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FLIGHT SIMULATION TRAINER THREAT ENVIRONMENT REQUEST FOR PROPOSAL REQUIREMENTS REPORT

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This report presents some details regarding the procurement of a Simulated Threat Environment, including mission requirements,the threats required to accomplish the mission requirements, the threat fidelity, the threat features, the methodology required to produce these threats and the validation tests to insure that the final product meets the original systems specifications.

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Specific aknowledgements are provided if a figure or table was generated exclusively by an individual. Most figures or tables were generated by myself and a combination of the above persons.

SUMMARY

The Navy is continually contracting for a Trainer Threat Environment without carefully generating a complete specification detailing exactly what is desired and how the development process will insure an optimum product. This report will provide some detail regarding the procurement of a simulated threat environment. The Threat Environment development process includes; identifying the mission requirements, the threats required to accomplish the mission requirements, the fidelity of the threats required to accomplish the mission requirements, the methodology required to produce these threats, and the validation tests to insure that the final product meets the original systems specifications. The Threat Environment Development Process is illustrated in Figure 1.

This report will also discuss each of the Threat Environment development blocks that are required for an effective Threat Environment Request For Proposal (RFP). A threat Environment, illustrated in Figure 2, will be defined as any aircraft (friendly or enemy excluding ownship), any missile (Friendly or enemy including ownship missiles), any sensor (friendly or enemy including ownship sensors), any ship (friendly or enemy), any ground site/platforms (friendly or enemy), any gun system (friendly or enemy), and any jammers, decoys or flares.

1.1 BACKGROUND

The NAVAIRDEVCEN with NAVAIR (Code PMA-205) as a sponsor, has been involved in the design of trainer threat environments for several years, including system specifications, fidelity requirements, validation test procedures, identificaiton of threat data, generation of high fidelity threat models and incorporation of threat models into flight simulators and trainers. The two major threat environment development programs that the NAVAIRDEVCEN has supported in the past several years are: the F-14D Trainer Development Program, and the Universal Threat System for Simulators (UTSS) Program.

The F-14D Trainer System includes five trainers located at NAS Oceana, VA, and five trainers located at NAS Miramar, CA. There is a dual dome Weapon System Trainer and three mission Flight Trainers at each location. The F-14D Trainer Threat Environment Request for Proposal Requirements are presented in Appendix A, for reference. As the development of the F-14D Trainer Program progressed certain factors regarding the threat environment envolved. Issues regarding threat fidelity, validation, memory requirements, computational time and systems architecture, identified the need for more detail in the original Contract Request for Proposal Specification.

The NAVAIRDEVCEN defines the UTSS concept as a Threat Environment Development Process. The NAVAIRDEVCEN identifies the final product as a catalog of threat models, including high and low fidelity threat models, classified and unclassified threat models and models, provided in FORTRAN software and in ADA software. The development process would include the generation and update of Systems Performance data and curves to be used in the generation of the treat model. The process will also include the identification of specific data sources to be used in the generation of the threat models, the validation of the threat models in an off-line computer, and maintenance of the threat environment, including strict configuration management. As the Universal Threat System for Simulation (UTSS) Program progressed certain threat environment issues evolved identifying the need for more specific detail regarding mission requirements, threat fidelity, model features, threat model data and validation methodology.

This report is intended for all flight simulation engineers requiring simulated threat models in their facilities.

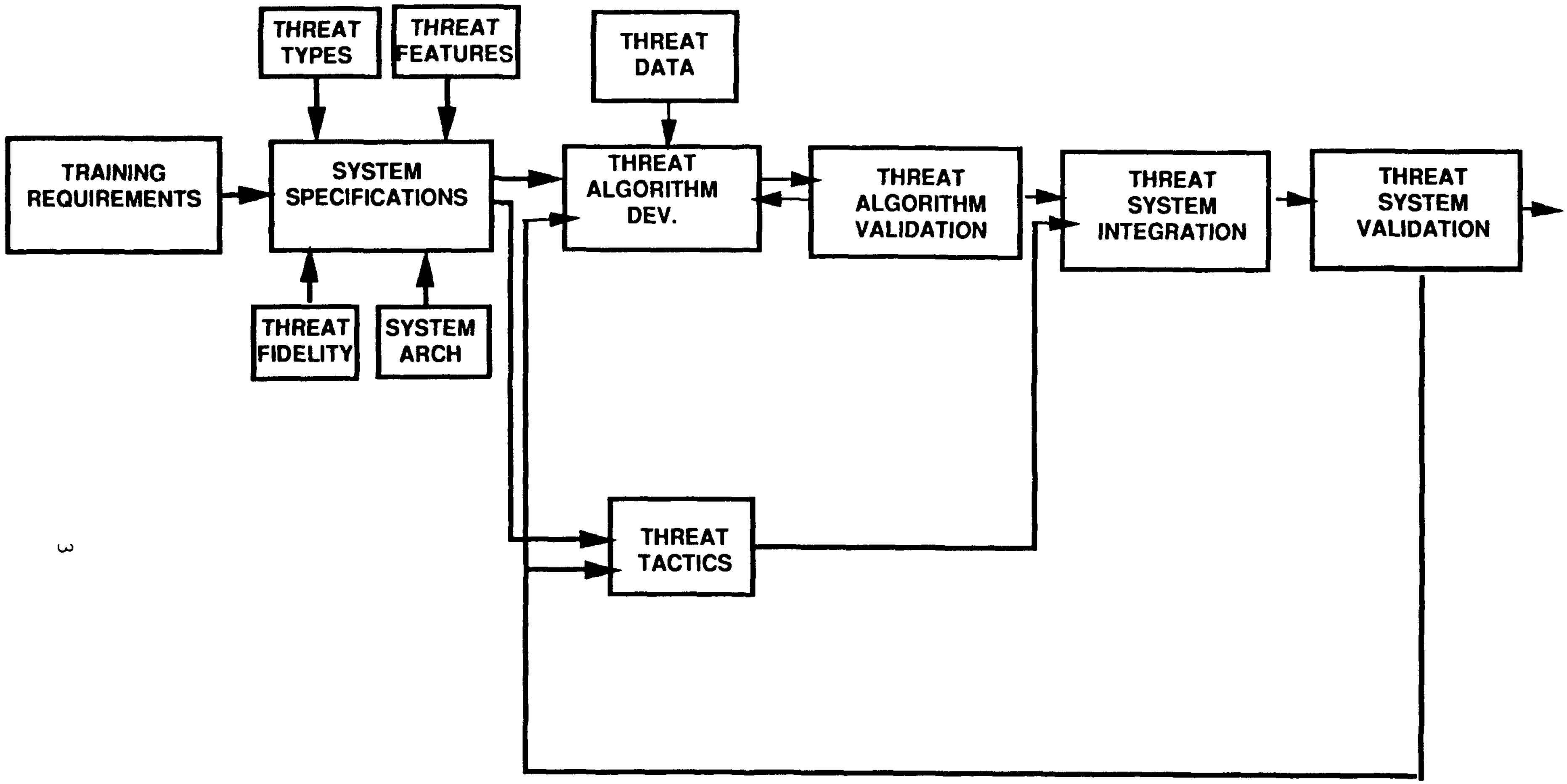


FIGURE 1 THREAT ENVIRONMENT DEVELOPMENT PROCESS

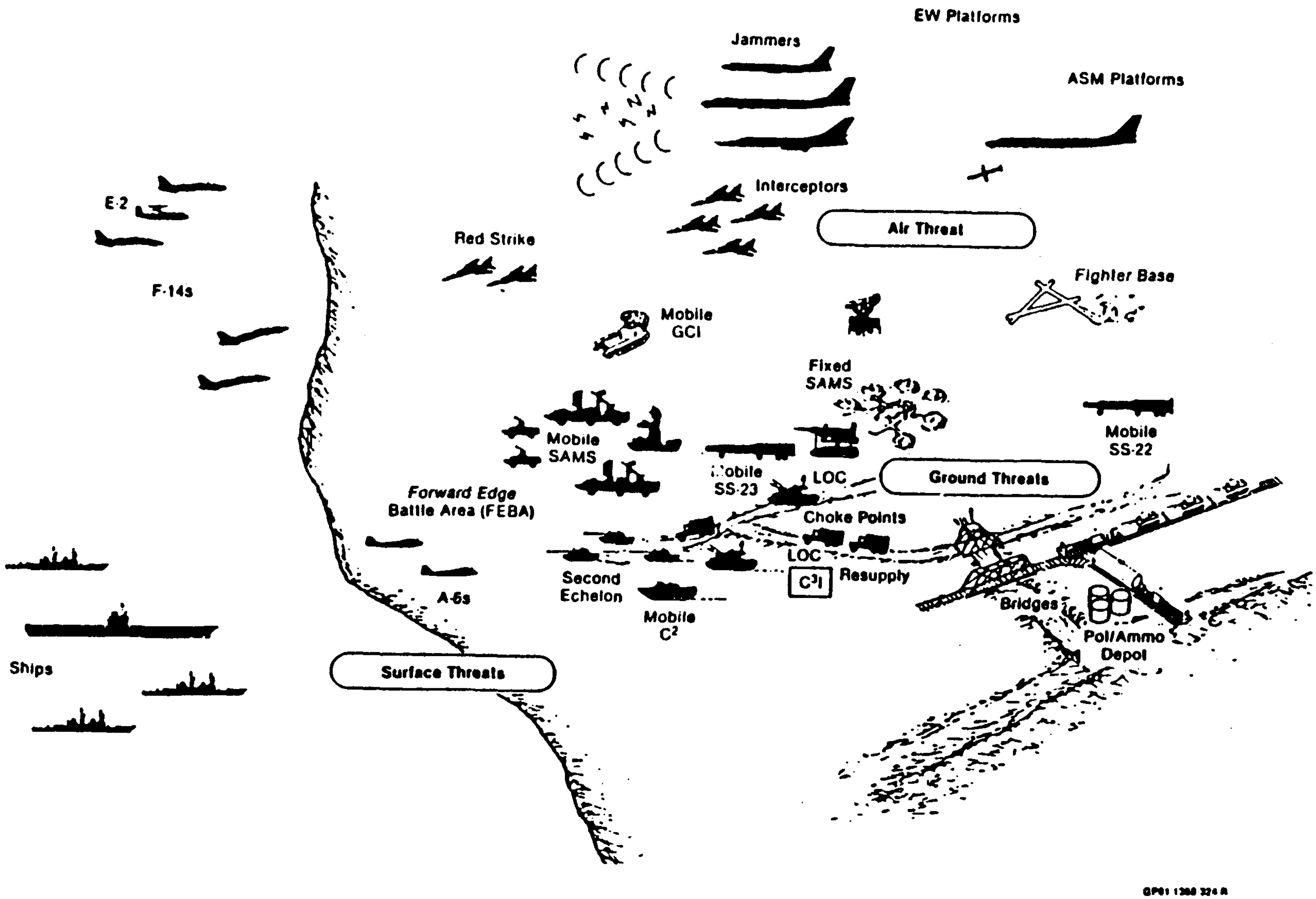


Figure 2. Pictorial of the Tactical Environment.

1.3 CONCLUSIONS AND RECOMMENDATIONS

The generation of a threat environment Request For Proposal (RFP) for a trainer or research flight simulator, requires the inclusion of the training or mission tasks, threats required to accomplish the tasks, fidelity of the threats to accomplish the tasks in an optimum manner, and identification of the threat model data sources.

Providing the threat System Specification (real world data to generate the threat model), and the specific model features required to meet the fidelity requirements, are valuable inputs in obtaining a high quality threat environment. The Systems Specification is used to validate the threat model. This information is difficult to obtain in a reasonable schedule. It must, however, be either provided in the RFP, or the contractor must be required to provide the details early in the threat environment development. Providing the general methodology in which the government will use to validate the threat models must be in the RFP to emphasize the fact that valid models are expected, as the product.

Requiring a specific design schedule in the RFP, for presenting analysis of the Systems Architecture, Threat Memory and Computation Time and Model Architecture designs, is important so that the threat environment development is in agreement with the governments desires.

2.0 Threat Environment Performance Specification

Information required in the Threat Environment Specification Section of the Request For Proposal should include the Training Mission Requirements, Threat Types, Systems Performance Specification (Threat Model Features & Threat Fidelity Requirements), Threat Data Source, and Threat Validation Methodology. Each of these subjects will be discussed in this section of the report.

2.1 Training Mission Requirements

The specific mission scenarios or training missions should be identified in the RFP to help bound the Threat Environment requirements. For example, if a air combat maneuvering (ACM) mission is required, then high fidelity adversary aircraft models are required. Training missions include Familiarization, Basic Instruments, Radio Instruments, Airways Navigation, Operational Navigation, Formation, Night Familiarization, Air-to-Air Gunnery, Air-to-Air Weapon Delivery, Air-to-Ground Weapon Delivery, Air-to-Surface Weapon Delivery, Carrier Landing, Air Escort, Threat Suppression, Mission Support, and Air Combat Maneuvering.

Not all these training missions need threats, so it is important to identify the specific mission requirements for a specific RFP and to identify the required tahreats to accomplish the mission objectives.

A second level of training missions might be useful. For example, Table 1, extracted from an Information Spectrum Incorporated UTSS presentation details trainer mission tasks, typical activities under the trainer missions, and typical ownship aircraft used for these activities.

2.2 Threat List Requirements

For each training mission identified in the RFP, a list of specific threats required to accomplish the mission should be generated.

The approach used in the F-14D Trainer RFP, as detailed in Appendix A, was to identify an overall threat environment support for all F-14D aircraft training mission tasks. This threat environment identified the need of 32 aircraft types, 18 antiship missile types, 24 air-to-1ir missile types, 18 surface-to-air missile types, 12 ship types, 128 ground site/platform types, 24 jammer types, and 128 radar/missile system/fire control system types. Shortly into the program the specific threats for each category were identified by the F-14D Fleet Project Team. This list is presented in Appendix B. This is a good list of threats in which a person can pick and choose for typical training missions.

Most trainer programs do not require a full threat environment. Providing a large threat environment is expensive, so it is important to correlate the specific required threats to the trainer missions. Selective threat type and their NATO names are presented in Figure 3.

Table 1. Generic Mission Definition for UTSS FEA.

GENERIC MISSION TITLE	TYPICAL ACTIVITY	TYPICAL AIRCRAFT
• SURFACE TARGET ATTACK (AIR-TO-GROUND GUNS/BOMBS/ MISSILES)	• CLOSE AIR SUPPORT • BATTLEFIELD AIR INTERDICTION • WAR-AT-SEA/SHORE BOMBARDMENT • DEEP STRIKE/INTERDICTION	F-16, F-15E, B-52, A-10, A-12, A-6E, B-1B, F/A-18, AH-64, ...
• AIR TARGET ATTACK (AIR-TO-AIR MISSILES & GUNS)	• FIGHTER SWEEP • HIGH-VALUE TARGET ATTACK • VECTOR AIR DEFENSE	F-16C, F-14A/D, F/A-18 ATF, NATF, LHX, ...
• AIR ESCORT	• AWACS DEFENSE • FIGHTER/BOMBER STRIKE PENETRATION	F-15A/C, F-14A/D, F/A-18, ATF, NATF, LHX, ...
• THREAT SUPPRESSION (ELECTRONIC/MISSILES/GUNS)	• ANTI-RADIATION DIRECT ATTACK • STANDOFF/PENETRATING ECM • ESM/EARLY WARNING • FIRE SUPPRESSION	F-4G, F-15E+, F/A-18, EF-111, EA-6B, ECF-130, ...
• MISSION SUPPORT	• RECONNAISSANCE • SEARCH & RESCUE • FORWARD AREA CONTROL • ASW • MILITARY AIRLIFT	RF-4, H-3, S-3, ASW HELO, KA6D, KCK-135, KC-10, ...

NATO NAMES

BOMBER/STRIKE AIRCRAFT

BACKFIRE - Tu-22M
BADGER - Tu-16
BEAR - Tu-20/Tu-142
BISON - Mya-4
BLACKJACK - Advanced Strategic Bomber
BLINDER - Tu-22
BREWER - Yak-28

SPECIAL-MISSION CARGO/TRANSPORT AIRCRAFT

COOT - Il-20
CRATE - Il-14
CUB - An-12

FIGHTER/FIGHTER-ATTACK AIRCRAFT

FENCER - Su-24
FIDDLER - Tu-28
FIREBAR - Yak-28P
FISHBED - MiG-21
FITTER - Su-20/22
FLAGON - Su-15
FLANKER - Su-27
FLOGGER - MiG-23/27
FORGER - Yak-38MP
FOXBAT - MiG-25
FOXHOUND - MiG-31
FROGFOOT - Su-25
FULCRUM - MiG-29

HELICOPTERS

HALO - Mi-26
HAVOC - Mi-28
HAZE - Mi-14
HELIX - Ka-27
HIND - Mi-24
HIP - Mi-8
HOKUM - Advanced-Technology Helicopter
HOOK - Mi-6
HOOP - Mi-29
HOPLITE - Mi-2
HORMONE - Ka-25
HOUND - Mi-4

Figure 3. Threat NATO Names (sheet 1 of 2).

MISCELLANEOUS/MARITIME AIRCRAFT

MAIL - Be-12
MAINSTAY - Il-76
MAY - Il-38
MOSS - Tu-126

SURFACE-TO-AIR MISSILE SYSTEMS (LAND)

SA-1 (GUILD): Yo-Yo Radar
SA-2 (GUIDELINE): Fan Song and Spoon Rest Radars
SA-3 (GOA): Low Blow and Flat Face Radars
SA-4 (GANEF): Pat Hand Radar
SA-5 (GAMMON): Square Pair Radar
SA-6 (GAINFUL): Straight Flush Radar
SA-7 (GRAIL): IR missile
SA-8 (GECKO): Land Roll, Thin Skin, Flat Face and Long Track Radars
SA-9 (GASKIN): IR missile
SA-10 (No NATO name)
SA-11 (No NATO name)
SA-X-12 (No NATO name)
SA-13 (GOPHER) IR missile
SA-14 (No NATO name) IR missile

SURFACE-TO-AIR MISSILE SYSTEMS (NAVAL)

SA-N-1 (GOA): Peel Group Radar
SA-N-3 (GOBLET): Head Light Radar
SA-N-4 (GRECHKO): Pop Group Radar
SA-N-5 (GRAIL): IR missile
SA-N-6 (GRUMBLE): Top Dome Radar
SA-N-7 (GADFLY): Front Dome Radar
SA-N-9 (No NATO name): Cross Sword Radar

Figure 3. Threat NATO Names (sheet 2 of 2).

2.3 THREAT SYSTEM SPECIFICATIONS

The Threat System Specification is defined as the real world data describing the performance of a threat to enable modeling of this threat. The generated threat model is measured against this real world data during the validation process.

(a) Aircraft System Specification

Typical Adversary Aircraft System Performance Specification Curves are presented in Figure 4. These curves are a representative sampling of the curves required.

(b) Missile System Performance Specification

Table 2 details the general missile performance specifications for missiles launched at/by ownship and missiles not launched at/by ownship. A value is required for each specific missile. A tolerence is presented for each value to provide the allowable difference between an existing model value and the required model value, as well as differences between reference models.

(c) Ground Based (EW) Surface-to-Air Missile Site System Specifications

Table 3 details the general ground based missile site system specifications that should be modeled to obtain the appropriate fidelity.

(d) Aircraft Gun System Performance Specification

Table 4 details the performance specification for aircraft gun systems.

THREAT SYSTEM PERFORMANCE SPECIFICATION

ADVERSARY AIRCRAFT (BVR & WVR)

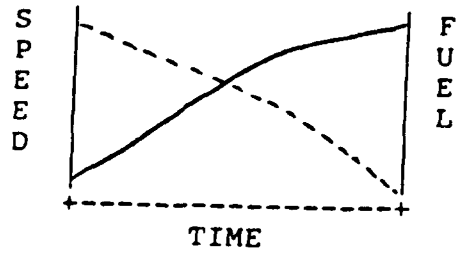
MASS PROPERTIES

GROSS WEIGHT XX,XXX LBS

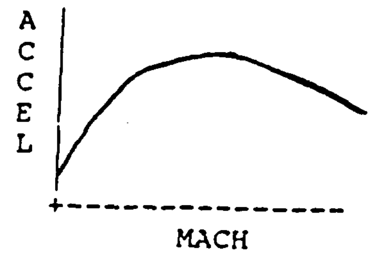
MOMENT OF INERTIA YYY,YYY SLUG-FT^2

PERFORMANCE

ACCELERATION

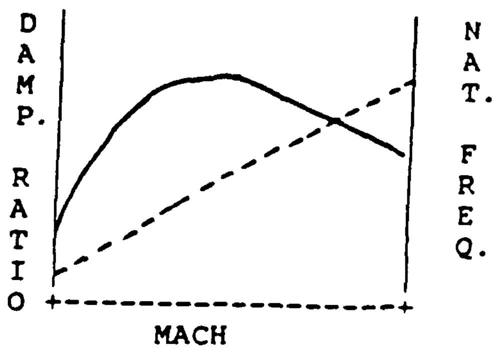


TURN PERFORMANCE



ADVERSARY AIRCRAFT (WVR - PILOTED)

DYNAMIC STABILITY



ROLL PERFORMANCE

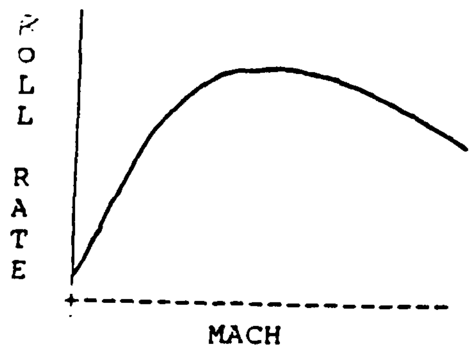


Figure 4. F-14D Trainer Threat Validation Procedure.

TABLE 2 MISSILE SYSTEMS SPECIFICATIONS.

MISSILE PROPERTIES	VALUE TOLERENCE: NOT LAUNCHED AT/BY OWNSHIP (LOW FIDELITY)	VALUE TOLERENCE: LAUNCHED AT/BY OWNSHIP (HIGH FIDELITY)
DEGREE OF FREEDOM	3	5 OR 6
INITIALIZATION FIRE CONTROL	LAUNCHED MODE, TARGET INFO, COCKPIT SWITCH SETTINGS, TRAJECTORY BIAS, STEERING (HEADING) COMMANDS	
AERODYNAMICS SYSTEM		
TRIM ANGLE-OF-ATTACK	± 5% (OR 1 DEG)	± 2% (OR 2 DEG)
TRIM ANGLE-OF-ATTACK	± 5% (OR 15FT/S/S)	± 2% (OR 2FT/S/S)
DRAG ACCELERATION NORMAL ACCELERATION LIMIT	± 5% (OR 15FT/S/S)	± 1% (OR 5FT/S/S)
GUIDANCE SYSTEM SEEKER LIMITS GIMBAL ANGLE	± 2 DEG	± 1 DEG
LINE-OF-SIGHT TRACK RATE	± 15% (OR 2 DEG/S)	± 10% (OR 1 DEG/S)
ACQUISITION RANGE (1 SQU TARGET)	± 4%	± 2%
CONTROL SYSTEM MAX CONTROL SURFACE DEFL	± 10% (OR 2 DEG)	± 5% (OR 1 DEG)
ACCEL LIMIT	± 10% (OR 30 FT/SEC)	± 5% (OR 15 FT/SEC)
MAX TIME OF FLIGHT	± 10% (OR 2.0 SEC)	± 5% (OR 1 SEC)

TABLE 2 MISSILE SYSTEMS SPECIFICATIONS (CONTD).

MISSILE PROPERTIES	$\boxed{\text{VALUE}}$ TOLERENCE	
	NOT LAUNCHED AT/BY OWNSHIP(LOW FIDELITY)	LAUNCHED AT/BY OWNSHIP (HIGH FIDELITY)
FAILURE CRITERIA		
MIN. VELOCITY (OR MACH)	$\boxed{}$ ± 10% (OR 50FT/S)	$\boxed{}$ +/-5% (OR 25FT/S)
MIN. CLOSING RATE	$\boxed{}$ ± 10% (OR 50FT/S)	$\boxed{}$ +/-5% (OR 25FT/S)
MIN. TOF	$\boxed{}$ ± 10% (OR 0.2 SEC)	$\boxed{}$ +/-5% (OR 0.1 SEC)
MAX. TOF	$\boxed{}$ ± 10% (OR 2.0 SEC)	$\boxed{}$ +/-5% (OR 1.0 SEC)
MAX. MISS DISTANCE	$\boxed{}$ ± 10% (OR 4 FT)	$\boxed{}$ +/-5% (OR 2FT)

TABLE 3. ELECTRONIC WARFARE SIMULATION PERFORMANCE SPECIFICATION.

COMPONENT	SELECTED FEATURE	TOLERANCE
BATTLE MANAGER /CCC	TARGET ASSIGNMENT LOGIC	FUNCTIONAL EQUIVALENT
	NETWORK DATA AVAILABILITY	FUNCTIONAL EQUIVALENT
	TIME DELAY	+/-10% (OR 1 SEC)
ADS SENSORS	GIMBAL ANGLE LIMIT	+/-5% (OR 1 DEG)
	DETECTION RANGE (1 SQM TARGET)	+/-5% (OR 5NM)
	MODE CONTROL LOGIC	FUNCTIONAL EQUIVALENT
	ECCM	FUNCTIONAL EQUIVALENT
	ANTENNA PATTERN	+/- 1.5 DB SIDE LOBES, ±.5DB GAIN
ADS DOCTRINE	LAUNCH/SALVO LOGIC	FUNCTIONAL EQUIVALENT
	BREAK-OFF/RELOAD LOGIC	FUNCTIONAL EQUIVALENT
	TARGET ASSIGNMENT LOGIC	FUNCTIONAL EQUIVALENT
RWR	Az/EL COVERAGE LIMIT	+/-5%
	SENSITIVITY	+/-10%
	TARGET LIBRARY	FUNCTIONAL EQUIVALENT
	TIME DELAY	+/-20%
SELF DEFENSE ECM	EMPLOYMENT LOGIC	FUNCTIONAL EQUIVALENT
	SIGNATURE	+/-10%
	FREQUENCY COVERAGE	+/-1%
	ERP VS. ANGLE	+/-10%
[illegible] ECM	SIMILAR TO SD ECM	SIMILAR TO SD ECM

TABLE 4. GUN PERFORMANCE SPECIFICATION.

ROUNDS EXPENDED	+/-5% (OR 5 RNDS)
TSPI (TRACER)	+/-100 FT (COMB X,Y,Z)
HIT PROBABILITY	+/-10% (OR 0.05)
TIME OF CLOSEST APPROACH	+/-5% (OR 0.1 SEC)
VELOCITY OF CLOSEST APPROACH	+/-5%
NUMBER OF HITS (PER 100 ROUNDS)	+/-10%

2.4 THREAT MODEL FEATURES

The threat model features are the requirements that the threat model must include for the model to replicate the real world data with the fidelity required to accomplish the training task.

(a) Aircraft Model Features

Table 5 details the general aircraft features that should be modeled to obtain the appropriate fidelity. This information was provided by Tom Galloway (NTSC). The features are needed in four categories of aircraft models; Beyond-Visual-Range, Within-Visual-Range, Close-In-Combat and Ownship. Beyond-Visual-Range Aircraft are defined as aircraft that are at least 15 miles from the ownship aircraft. Close-In-Combat Aircraft are defined as aircraft that the ownship would specifically engage in an air-to-air combat maneuvering battle. Within-Visual-Range aircraft are defined as those aircraft that are less than 15 miles from the ownship, but will not engage the ownship in air-to-air combat maneuvering. Both Close-In-Combat and Within-Visual-Range aircraft may be Interactive Aircraft. Interactive Aircraft know where other aircraft are in the threat environment and can fire missiles at the ownship.

(b) Missile Model Features

Table 6 details the general missile features that should be modeled to obtain the appropriate fidelity. Missile features are presented in two categories; missile launch at/by ownship, and missile not launched at/by ownship.

(c) Ground Based (EW) Surface-to-Air Missile Site Features

Table 7 details the general ground based missile site features that should be modeled to obtain the appropriate fidelity.

TABLE 5. GENERAL AIRCRAFT MODEL FEATURES.

AIRCRAFT PROPERTIES	LOW FIDELITY REQUIREMENTS			
	BVR	WVR	CIC	OWNSHIP
COMPUTER/PILOT COMMAND INPUTS INITIALIZATION FIRE CONTROL	HEADING ALTITUDE AIRSPEED	HEADING ALTITUDE AIRSPEED BANK ANGLE ACCELERATION THROTTLE	STICK THROTTLE PEDALS HEADING ALTITUDE AIRSPEED BANK ANGLE ACCELERATION	STICK THROTTLE PEDALS HEADING ALTITUDE AIRSPEED BANK ANGLE ACCELERATION
DYNAMIC LIMITS	TURN RATE ACCELERA- TION V(MAX) RATE-OF- CLIMB	TURN RATE ACCELERATION V(MAX) RATE-OF-CLIMB LIFT AERO COEF DRAG AERO COEF AOA PITCH RATE ROLL RATE	TURN RATE ACCELERA- TION V(MAX) RATE-OF- CLIMB LIFT DRAG LOW/HI AOA PITCH MOM & RATE ROLL MOM & RATE YAWMOM & RATE WEIGHT & RATE C.G. INERTIA	TURN RATE ACCELERATION (MAX) RATE-OF-CLIMB LIFT DRAG LOW/HI AOA PITCH MOM & RATE ROLL MOM & RATE YAW MOM & RATE WEIGHT & RATE C.G. INERTIA
MECHANICAL CHARACTERISTICS SAS/CONT AUG	-	-	FCS	FCS
THRUST FUEL FLOW DYNAMICS	-	-	ENGINE	ENGINE
DEGREE-OF-FREEDOM	3	5(NO YAW)	6	6

TABLE 6. GENERAL MISSILE FEATURES.

MISSILE PROPERTIES	FIDELITY REQUIREMENTS NOT LAUNCHED AT/BY OWNSHIP (LOW FIDELITY)	FIDELITY REQUIREMENTS LAUNCHED AT/BY OWNSHIP (HIGH FIDELITY)
DEGREE-OF-FREEDOM	3	5 OR 6
INITIALIZATION PHYSICAL DIMENSIONS	CONFIGURATION LENGTH, DIAMETER, AREA WEIGHT, CENTER-OF-GRAVITY, MOMENT, OF INERTIA, CONTROL SURFACE LOCATION	
FIRE CONTROL	LAUNCH MODE, TARGET INFO, COCKPIT SWITCH SETTINGS, TRAJECTORY BIAS, HEADING	
AERODYNAMICS SYSTEM	AXIAL FORCE COEFFICIENT ZERO LIFT DRAG COEF VS MACH & THRUST	AXIAL FORCE COEFFICIENT ZERO LIFT DRAG COEF VS MACH & THRUST INCREMENTAL AXIAL FORCE COEF VS MACH, AOA & CONTROL SURFACE DEFLECTION NORMAL FORCE COEFFECIENT VS MACH, AOA & CONTROL SURFACE DEFLECTION MOMENT COEEFICIENT VS MACH, AOA, CONTROL SURFACE DEFL DAMPING MOMENT COEFFICIENT VS MACH AOA & CONTROL SURFACE DEFL SKID TO TURN, BANK TO TURN

TABLE 6. GENERAL MISSILE FEATURES (CONTD).

MISSILE PROPERTIES	FIDELITY REQUIREMENTS	
	NOT LAUNCHED AT/BY OWNSHIP (LOW FIDELITY)	LAUNCHED AT/BY OWNSHIP (HIGH FIDELITY)
GUIDANCE SYSTEM	GUIDANCE FUNCTIONS (RANGE, RANGE RATE, SPATIAL ANGLES, ANGLE RATE) TYPE (ACTIVE, SEMIACTIVE, PASSIVE) GUIDANCE LAW, GUIDANCE DELAYS, GIMBAL CONFIGURATION, LINE OF SIGHT RATE, GUIDANCE GAIN & BIASES, NOISE FILTER	
SEEKER	MAX TRACKING RATE MAX GIMBAL ANGLES ILLUMINATION REQUIREMENTS	SENSITIVITY, OPERATING FREQUENCY BANDS SEARCH PATTERNS, ACQUISITIONS & DELAYS LOCK-ON CHARACTERISTICS AND LOGIC, ILLUMINATION REQUIREMENTS, AND TARGET TRACKING DYNAMICS ECM SUSCEPTIBILITY SIGNAL PROCESSING TYPE CLUTTER REJECTION GIMBAL LIMITS SEEKER CHARACTERISTIC TYPE
CONTROL SYSTEM	ACCELERATION LIMIT MAX TOF MIN DYNAMIC PRESSURE	AUTO PILOT GAINS AUTOPILOT TIME CONSTANT MAX CONTROL SURFACE DEFLECTION ACCELERATION LIMIT MAX TIME OF FLIGHT MIN DYNAMIC PRESSURE FEEDBACK GAINS, LIMITS AND TIME CONSTRAINTS CONTROL INITIATION TIME
ARMAMENT SYSTEM	MAX MISS DISTANCE PK MIN FUZING TIME	FUSE PARAMETER MIN FUZING TIME TYPE BEAM ANGLES MAX ALLOWABLE MISS LOGIC W/H - TYPE/KILL MECHANISM WEIGHT LETHAL RADIUS

TABLE 6. GENERAL MISSILE FEATURES (CONTD).

<table>
<tr><th rowspan="2">MISSILE PROPERTIES</th><th colspan="2">FIDELITY REQUIREMENTS</th></tr>
<tr><th>NOT LAUNCHED AT/BY OWNSHIP(LOW FIDELITY)</th><th>LAUNCHED AT/BY OWNSHIP (HIGH FIDELITY)</th></tr>
<tr><td rowspan="2">FAILURE CRITERIA</td><td colspan="2">INSIDE MINIMUM RANGE
OUTSIDE MAXIMUM RANGE
INSUFFICIENT MISSILE VELOCITY
MISSILE GIMBAL LIMIT EXCEEDED
SEEKER LOST LOCK - EXCESSIVE LOS RATE
INTERCEPT TIME LESS THAN SAFE ARMING TIME
EXCEEDED ALLOWABLE MISS DISTANCE
INSUFFICIENT CLOSING RATE
MISSILE INTERCEPT THE GROUND
SENSOR ELEVATION GIMBAL LOCK</td></tr>
<tr><td></td><td>LOS RATE EXCEEDED MISSILE MANEUVER CAPABILITY
A/C RADAR NOT LOCKED ON AT LAUNCH
INSUFFICIENT CLOSING VELOCITY AT LAUNCH
EXCEEDED MAXIMUM FLIGHT TIME
CLUTTER
SEEKER FIELD OF VIEW EXCEEDED
ROLL CYRO GIMBAL LOCK</td></tr>
</table>

TABLE 7. TYPICAL ELECTRONIC WARFARE MODEL FEATURES.

COMPONENT	SELECTED FEATURE
BATTLE MANAGER /CCC	AIRCRAFT UNDER SURVIELLANCE (A/C ID, START/STOP TIME)
	TARGET ASSIGNMENTS (TARGET ID, SAM ID, TIME)
	MODE ASSIGNMENTS (SAVE ID, MODE, TIME)
ADS SENSORS	TRACK START/END TIME
	PRIMARY MODE SWITCHES (MODE, TIME)
	REASON FOR TRACK LOSS
ADS DOCTRINE	TIME OF FIRST LAUNCH
	SALVO (NUMBER AND INTERVAL)
	TIME OF BREAK-OFF
	NUMBER OF LAUNCHES
	REATTACK
RWR	TIME OF FIRST WARNING
	TIME OF WARNING END
	CORRECT DISPLAY SYMBOL
SELF DEFENSE ECM	ACTIVATION & STOP TIMES ECM TYPE TRACK BREAK TIME
	KILL PROBABILITY REDUCTION
SUPPORT ECM	AIRCRAFT SCREENED (A/C ID, START/STOP TIME)
	JAM-TO-SIGNAL RATIO
SITF ECCM	TYPE, EFFECTIVENESS

2.5 THREAT FIDELITY REQUIREMENTS

Once the trainer mission requirements are determined and the threats required to accomplish the trainer missions are determined, the fidelity requirement of these threats must be determined. Threat fidelity is the deviation that is allowable from the real world data describing the performance of a threat. Ideally, all threats would be modeled to a high fidelity; however, computational capabilities of the typical simulation computers do not allow all high fidelity models. For example, the F-14D Trainer high fidelity Close-In-Combat threat aircraft model, requires one Gould 32/67 computer for each model. If 35 of these high fidelity models were required in the threat environment, then 35 of these computers would be required.

This section of the report will detail fidelity requirements for a range of high and low fidelity threats including aircraft, missiles, ground-based (EW) missile sites, radar and guns.

(a) Aircraft Fidelity Requirements

Fidelity Requirements are needed in four categories of aircraft; Beyond-Visual Range, Within-Visual Range, Close-In-Combat and Ownship.

Table 8 provides the specific aircraft fidelity requirements for the four categories of fidelity.

The F-14D Trainer System Specification provided detailed fidelity requirements for ownship (Appendix C), but neglected to provide fidelity requirements for the other three categories. This technically allowed the contractor to provide threat models with any fidelity their conscience would allow.

(b) Missile Fidelity Requirements

Missile Fidelity Requirements are needed in two categories; missile launched at/by ownship, and missile not launched at/by ownship.

Table 9 provides specific Missile Fidelity Requirements. The parameters identified are based on the NAVAIRDEVCEN Low Cost Validation of a Blue and Red TACTS Range missile model. A selective minimal number of critical parameters were measured to provide validation of the missile models at a reasonable cost. Specific missile model parameters[4] to develop an algorithm that would provide the appropriate fidelity requirement are presented in Table 10.

(c) Ground-Based (EW) Surface-to-Air Missile Site Fidelity Requirements

Table 11 details the general ground based Missile Site Fidelity Requirements.

TABLE 8. SPECIFIC AIRCRAFT FIDELITY REQUIREMENTS.

AIRCRAFT PERFORMANCE	FIDELITY REQUIREMENTS BVR	WVR	CIC	OWNSHIP
GENERAL				
TOTAL MASS	1 PERCENT			
MOMENTS OF INERTIA	1 PERCENT OR 0.1 PERCENT OF MAXIMUM VALUE WHICHEVER IS GREATER			
ATTITUDE ACCURACY	1 DEGREE			
ATTITUDE RESOLUTION	0.1 DEGREE			
CENTER OF GRAVITY	± .2% MAC.			
CURVE SLOPE	± 1% TRAINER CRITERIA CURVE			SEE APPENDIX C
POWER PLANT CHARACTERISTICS				
FUEL FLOW	5 PERCENT			
RPM	5 PERCENT			
FUEL QUANTITY	5 PERCENT			
PERFORMANCE CHARACTERISTICS				
RATE OF CLIMB	5 PERCENT OR 50 FEET PER MINUTE , WHICHEVER IS GREATER			
LEVEL ACCELERATION/ DECELERATION (TIME AND FUEL USED)	5 PERCENT			

TABLE 8. SPECIFIC AIRCRAFT FIDELITY REQUIREMENTS (CONTD).

AIRCRAFT PERFORMANCE	FIDELITY REQUIREMENTS BVR	WVR	CIC	OWNSHIP
MAXIMUM AIRSPEED	3 KNOTS OR 1 PERCENT, WHICHEVER IS GREATER			
TURN PERFORMANCE (SUSTAINED AND INSTANTANEOUS	5 PERCENT OR 0.1 G, WHICHEVER IS GREATER			
CONTROL SYSTEM				
SURFACE DEFLECTION VS CONTROL DEFLECTION			0.5 DEGREE	SEE APPENDIX C
CONTROL FORCE VS CONTROL DEFLECTION			5 PERCENT OR $\frac{1}{2}$ POUND, WHICH IS GREATER	
BREAKOUT PLUS FRICTION FORCE			$\frac{1}{2}$ POUND	
FRICTION BAND			$\frac{1}{2}$ POUND	
FREE PLAY			0.10 INCH	
TIME FOR OPERATION OF TRIM SYSTEM, FLAP ACTUATION, SPEED BRAKE ACTUATION, ETC.			5 PERCENT	
DAMPING RATIO			0.05	
UNDAMPED NATURAL FREQUENCY			10 PERCENT	
AMPLITUDE RESPONSE			10 PERCENT	

TABLE 8. SPECIFIC AIRCRAFT FIDELITY REQUIREMENTS (CONTD).

AIRCRAFT PERFORMANCE	FIDELITY REQUIREMENTS			
	BVR	WVR	CIC	OWNSHIP
FLYING QUALITIES				SEE APPENDIX C
STEADY STATE TRIM POINTS:				
ANGLE OF ATTACK VS TRIM AIRSPEED			0.5 UNIT ANGLE OF ATTACK	
TRIM SURFACE DEFLECTION VS AIRSPEED			10 PERCENT OR 1 DEGREE WHICHEVER IS GREATER	
STATIC LONGITUDAL STABILITY:				
SURFACE DEFLECTION VS AIRSPEED			0.5 DEGREE OR 10 PERCENT WHICHEVER IS GREATER	
DYNAMIC LONGITUDAL STABILITY (SHORT PERIOD):				
DAMPING RATIO			0.05	
UNDAMPED NATURAL FREQUENCY			10 PERCENT	
MANEUVERING LONGITDUAL STABILITY:				
ANGLE OF ATTACK VS NORMAL ACCELERATION		0.5 DEGREE OR 10 PERCENT, WHICHEVER IS GREATER		
SURFACE DEFLECTION VS ACCELERATION			0.5 DEGREE OR 10 PERCENT, WHICHEVER IS GREATER	
STATIC LATERAL-DIRECTIONAL STABILITY:				
ROLL ANGLE VS SIDESLIP ANGLE			1.0 DEGREE OR 10 PERCENT, WHICHEVER IS GREATER	

TABLE 8. SPECIFIC AIRCRAFT FIDELITY REQUIREMENTS (CONTD).

AIRCRAFT PERFORMANCE	FIDELITY REQUIREMENT			
	BVR	WVE	CIC	OWNSHIP
DYNAMIC LATERAL DIRECTIONAL STABILITY:				
DUTCH ROLL PERIOD VS AIRSPEED			10 PERCENT	
DUTCH ROLL DAMPING VS AIRSPEED			0.05	
ROLL TO SIDESLIP RATIO			10 PERCENT	
SIDESLIP ANGLE VS TIME			10 PERCENT OR 1 DEGREE OF PEAK AMPLITUDE, WHICHEVER IS GREATER	SEE APPENDIX C
LATERAL CONTROL EFFECTIVENESS:				
ROLL ANGLE VS TIME		10 PERCENT		
SIDESLIP ANGLE VS TIME		10 PERCENT		
ROLL RATE VS TIME		10 PERCENT		
ROLL MODE TIME CONSTANT			25 PERCENT	
STALL CHARACTERISTICS (1G):				
BUFFET ONSET SPEED VS GROSS WEIGHT			2 KNOTS	
STALL SPEED VS GROSS WEIGHT			2 KNOTS	
BUFFET ONSET ANGLE OF ATTACK			0.5 UNIT	
STALL ANGLE OF ATTACK		0.5 UNIT		
DEGREE OF FREEDOM	3	5	6	6

TABLE 9. MISSILE FIDLEITY REQUIREMENTS.

MISSILE PROPERTIES	FIDELITY REQUIREMENTS	
	NOT LAUNCHED AT/BY OWNSHIP	LAUNCHED AT/BY OWNSHIP
INTERCEPT VELOCITY	$\pm$10% (OR 75FT/S)	+/-5% (OR 50FT/S)
TIME OF FLIGHT	$\pm$10% (OR 10% MAX TOF)	+/-5% (OR 1 SEC)
MAX RANGE BOUNDARY	$\pm$10% (OR 3000 FT)	+/-5% (OR 2000 FT)
MIN RANGE BOUNDARY	1500 FT	1000 FT
FAILURE REASON	EQUIVALENCE	EQUIVALENCE

TABLE 10. SPECIFIC MISSILE PARAMETERS

MISSILE PARAMETERS	UNITS
INITIALIZATION	
PHYSICAL DIMENSIONS	
MISSILE LENGTH	FT
MISSILE DIAMETER	FT
MISSILE WEIGHT (INCL VARIANCE DURING FLIGHT)	LBS
MISSILE CENTER OF GRAVITY (INCL VARIANCE DURING FLIGHT)	FT
MISSILE MOMENT OF INERTIA (INCL VARIANCE DURING FLIGHT)	SLUG*FT**2
NOZZLE EXIT AREA	FT**2
THRUST (INCL VARIANCE DURING FLIGHT)	LBS
FIRE CONTROL	
ACM MODE SWITCH	
WIDE/NARROW DOPPLER GATE SWITCH	
TARGET ILLUMINATION STATE	
TARGET STATE VECTORS (IF REQ)	
LAUNCH MODE (IF APPLICABLE)	
SEEKER SYSTEM	
TRACKING LOOP TIME CONSTANT	SEC
TRACKING LOOP GAIN	(DEG/SEC)/DEG
NOISE FILTER TIME CONSTANT	SEC
SEEKER OFF-BORESIGHT LINEAR TRACKING LIMIT	DEG/SEC
SEEKER FIELD-OF-VIEW	DEG
GIMBAL ANGLE LIMIT	DEG
TRACKING RATE LIMIT	DEG
SPEED GATE TRACKING GAIN	1/SEC
MINIMUM DOPPLER CLOSING RATE	FT/SEC
MAXIMUM DOPPLER CLOSING RATE ERROR	FT/SEC
ANTENNA BEAMWIDTH	HZ
RADAR TIME DELAYS	SEC
GUIDANCE SYSTEM	
NAVIGATION GAIN	G/(DEG/SEC)/(FT/SEC)
GUIDANCE COMMAND LIMIT	G
VERTICAL BIAS	G
BIAS INITIATION TIME	SEC
BIAS TERMINATION TIME	SEC
BIAS LOGIC	VARIABLE
MAXIMUM BIAS LIMIT	VARIABLE

TABLE 10. SPECIFIC MISSILE PARAMETERS (CONTD).

MISSILE PARAMETERS	UNITS
AERODYNAMIC SYSTEM	
AXIAL FORCE	
- ZERO LIFT DRAG COEFFICIENT (FUNCTION OF MACH AND THRUST LEVEL	-
- INCREMENTAL AXIAL FORCE COEFFICIENT (FUNCTION OF ANGLE OF ATTACK, CONTROL SURFACE DEFLECTION, AND MACH)	-
NORMAL FORCE	
- NORMAL FORCE COEFFICIENT (FUNCTION OF MACH, ANGLE OF ATTACK, AND CONTROL SURFACE DEFLECTION	-
MOMENT	-
- MOMENT COEFFICIENT (FUNCTION OF MACH, ANGLE OF ATTACK, WING DEFLECTION)	-
- DAMPING MOMENT COEFFICIENT (FUNCTIONS OF MACH, ANGLE OF ATTACK, AND CONTROL SURFACE DEFLECTION	
REFERENCE AREA	FT**2
REFERENCE LENGTH	FT
REFERENCE CENTER OF PRESSURE	FT
CONTROL SYSTEM	
AUTOPILOT GAINS AND LIMITS	
AUTOPILOT TIME CONSTANT	SEC
MAXIMUM CONTROL SURFACE DEFLECTION	DEG
ACCELERATION LIMIT	G
MAXIMUM TIME OF FLIGHT	SEC
MINIMUM SPEED	FT/SEC
MINIMUM DYNAMIC PRESSURE	LB/FT**2
BIASES	G

TABLE 10. SPECIFIC MISSILE PARAMETERS (CONTD).

MISSILE PARAMETERS	UNITS
SCORING PARAMETERS	
MINIMUM SAFE ARMING TIME	SEC
MINIMUM CLOSING RATE	FT/SEC
MAXIMUM ALLOWABLE MISS DISTANCE	FT
PROBABILITY OF KILL DATA	

TABLE 11. ELECTRONIC WARFARE SIMULATION FIDELITY REQUIREMENTS.

COMPONENT	SELECTED FEATURE	TOLERANCE
BATTLE MANAGER /CCC	AIRCRAFT UNDER SURVEILLANCE (A/C ID, START/STOP TIME)	+/- 5 SECONDS
	TARGET ASSIGNMENTS (TARGET ID, SAM ID, TIME)	+/- 2 SECONDS
	SITE CONTROL LOGIC	EQUIV
ADS SENSORS	TRACK START/END TIME	+/- 2 SECONDS
	PRIMARY MODE SWITCHES (MODE, TIME)	+/- 2 SECONDS
	REASON FOR TRACK LOSS	EQUIVALENCE
ADS DOCTRINE	TIME OF FIRST LAUNCH	+/- 2 SECONDS
	TIME OF BREAK-OFF	+/- 2 SECONDS
	NUMBER OF LAUNCHES	EQUIVALENCE
RWR	TIME OF FIRST WARNING	+/- 2 SECONDS
	TIME OF WARNING END	+/- 2 SECONDS
	CORRECT DISPLAY SYMBOL	EQUIVALENCE
SELF DEFENSE ECM	ACTIVATION & STOP TIMES	+/- 2 SECONDS
	TRACK BREAK TIME	+/- 2 SECONDS
	KILL PROBABILITY	TBD
SUPPORT ECM	AIRCRAFT SCREENED (A/C ID, START/STOP TIME)	+/- 2 SECONDS
	JAM-TO-SIGNAL RATIO	+/- 3DB
SITE ECCM	EFFECTIVENESS	EQUIV

2.6 THREAT MODEL DATA

Identifying threat reference data sources is a key element in developing accurate threat simulators for training. Alfred Gramp, TACTS/ACMI Range Threat Environment Simulation Program Manager, has identified the following sources for threat system reference data.[5]

Threat (Red/Orange) Air-to-Air Guided Weapons
- U.S. Air Force Foreign Technology Division (FTD), Wright Patterson AFB, OH
- TRAP Simulations & Data Packages
- FTD Air-to-Air Guided Weapon Documents

Threat (Red/Orange/Gray) Land Based Surface-to-Air Missiles
- U.S. Army Missile and Space Intelligence Center (AMSIC), Redstone Arsenal, Huntsville, AL
- IMARS and/or MISSIM Models (if available)
- DIA Documents
- ESAMS Simulations and Documentation (Updated TACZINGERS & SAMS), SURVIAC, Wright Pat AFB
- SIMVAL Simulations and Documentation, Wright Pat AFB

Threat (Red/Orange) Anti-Air Artillery (AAA)
- U.S. Army Foreign Science and Technology Center (FSTC), Charlotte, VA
- RADGUN Simulations and Data Bases
- DIA Documentation

Threat (Red/Orange) Naval SAMs and AAAs
- U.S. Navy Naval Technology Intelligence Center, Washington, D.C.
- NSAM Simulations
- DIA Documentation
- FSTC
- RADGUN Simulations and Data Bases (if available)

General Threat Data
- MCM-3-1 Document [Note: Coarse data; No Contractor]
- EWIR Data Bases [Note: Includes Kilting Data; Contractor and No Contractor Versions]
- DIA Documentation

Friendly (Blue/Gray) Air-to-Air Weapons
- AIM-7E-2, 7F Sparrow
- Naval Research Lab (NRL; Original Source of Data)
- Naval Weapons Center (NWC)
- Pacific Missile Test Center (PMTC)

- AIM-7M Sparrow
- PMTC (Note: model performance differs significantly from those above; JTCG Validation of near-real-time or faster AIM-7F models against telemetry data in the early 80's indicated PMTC model performance was worst among available models; TACTS AIM-7F was chosen as most accurate.

- AIM-54A/C Phoenix
- Hughes Simulation and Documentation
- Naval Air Development Center (NADC) Simulation and Documentation
- AIM-9D/G/H/L/M Sidewinder
- NWC Simulations and Documentation

- AIM-9J/P/N Sidewinder
- Eglin AFB Simulations and Documentation (Note: Provide increased aero performance over NWC baseline)

- AIM-120 AMRAAM
- Eglin AFB Simulation and Documentation
- Hughes Simulation and Documentation (Original Source)
- Sverdrop Simulation Enhancements (Build on Hughes Model)

- M61-A1 Guns
- Eglin AFB GAMES Simulation and Documentation (Original source; P001 derivative)

- GAU-8 Guns
- Eglin AFB & Nellis AFB Documentation

Friendly Air-to-Surface Weapons

- AGM-45A/B Strike
- NWC Simulation and Documentation

- AGM-88 HARM
- John Hopkins Univ./Applied Physics Lab (JHU/APL) Simulation and Documentation
- NWC Documentation

- Laser Guided Bombs
- MK-82/83/84 Paveway II Simulation and Documentation-NWC
- AGM-123 Skipper Simulation and Documentation - NWC
- Air Force Peculiar Sims and Doc - Eglin AFB ??

- AGM-84 Harpoon
- PMTC Simulation and Documentation
- Center for Naval Analysis (CNA) Prob of Acquisition Model and Documentation
- Mac Air Documentation
- JHU/APL
- DELEX

- Bombs/Mines/Rockets - No Drop Weapon Scoring
- Navy weapons: Data from NATC and/or NSWC (Dahlgren)
- Air Force weapons: Data from Eglin AFB

- Tactical Air Launched Decoy (TALD)
- Brunswick model (Not Deliverable to Government)
- NADC, NATC, NSWC (Strike U., Fallon, NV),...Documentation

Friendly Naval Surface-to-Air Weapons

- Naval SAMs and AAAs
- Naval Surface Weapons Center (NSWC), Dahlgren, VA

Other Friendly (Blue/Gray) Weapons

- Simulation and Documentation - Lead Activity

2.7 THREAT VALIDATION METHODOLOGY

The majority of flight simulation threat models have not been validated. Usually the threat environment is exercised flying a typical mission scenario and subjectively viewing the threat model performance. The NAVAIRDEVCEN has identified a need for measuring a typical threat model against the threats real world performance data (identified in the Systems Performance Specification) in an off-line computer, using the fidelity requirements as the allowable deviation. This Threat Model Validation Concept, generated for the F-14D Trainer Program, is illustrated in Figure 5. For example, as detailed in Reference [6], a TACTS Range AIM-9L missile model was measured against the Naval Weapons Center (China Lake) reference model, using nine validation check cases. Several check cases reflecting various geometries and kinematic conditions must be examined to explore resulting weapon performance.

The AIM-9L missile parameters used in the validation included intercept time-of-flight, velocity at intercept, reason for miss, maximum range and minimum range. The results of the TACTS Range AIM-9L candidate model were measured against the China Lake AIM-9L reference model to determine the percenage of deviation. This deviation was in turn measured against an allowable deviation specified as part of the fidelity requirements. A block diagram similar to the one illustrated in Figure 5 should be identified in the RFP to provide guidance to the contractor regarding the methodology used to validate their threat models, the validation parameters, allowable deviations from reference data, and a schedule for the process to occur.

3.0 THREAT ENVIRONMENT DEVELOPMENT

The Threat Environment Development Request for Proposal should include a Performance Specification, but should not dictate the design. However, certain design criteria must be identified to provide for an optimum system. The Threat Environment Systems architecture, computer memory requirements, threat computational time requirements and model architecture, are some of these elements that should be mentioned in the RFP. This section of the report will discuss these design parameters.

In general, it would be useful to present, in the RFP, the important features required in the design of a threat environment, such as the model computational time and memory requirements, and provide a check-off list of when the contractor is expected to provide the details of these design parameters. Request for these design details during the F-14D Trainer development program were not always accommodated.

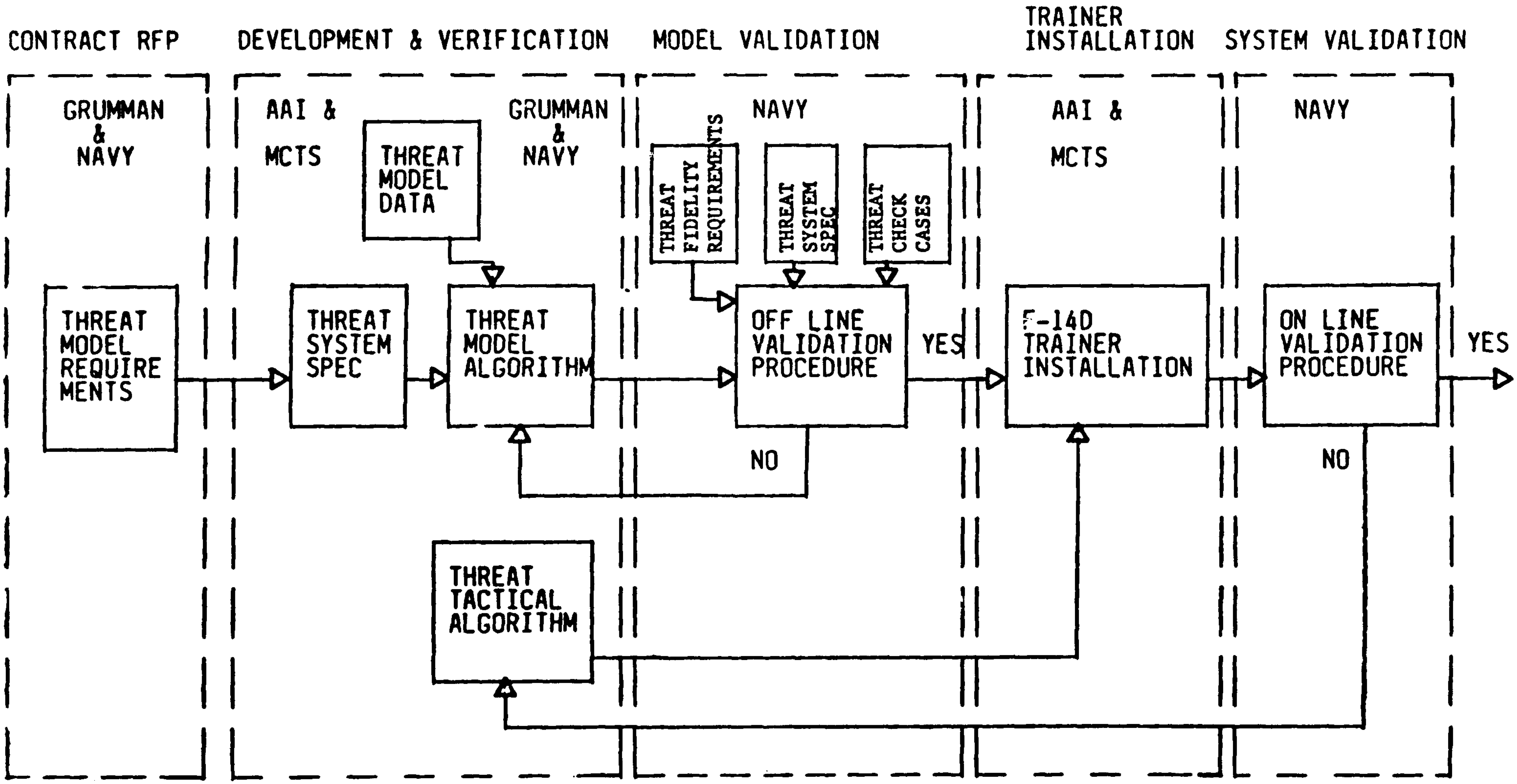


Figure 5. F-14D Trainer Threat Validation Procedure.

3.1 SYSTEMS ARCHITECTURE

The systems architecture depends on many factors including the training tasks, threat types, number of threats, and their respective fidelity requirements. As summarized in Figure 6, a careful trade-off of the threat system architecture design factors, such as computer resources, computer configuration, Bus configuration, processing time techniques, memory expansion techniques, I/O techniques, and model transition techniques, must be analyzed to identify a computer system that will provide the correct computational capability required.

Model transition refers to the situation in which an active model is converted from a high fidelity to a low fidelity model, or visa versa, during an active mission scenario. The RFP should identify this need, and require a trade-off analysis be presented at the Preliminary Design Review. The contractor should provide a preliminary copy of the Math Model Report, as early as possible, so that the government can provide inputs to the design approach. A typical MIL-STD 2167 review schedule is presented in Figure 7 with selective threat environment design factors required.

3.2 THREAT MEMORY AND COMPUTATIONAL TIME REQUIREMENTS

The Threat Model Memory and Computational Time Requirements is driven by model fidelity and the number of simulations running simultaneously. DOD Standard 2167 requires this information to be identified in the Software Design Document (Data Item Description No. DI-MCCR-80012A) which is presented at the Preliminary Design Review and the Critical Design Review. It is important to require this information periodically to insure that the threat environment design is sound. A statement in the RFP identifying the requirement to present this information at the Preliminary and Critical Design Reviews will emphasize the point.

3.3 MODEL ARCHITECTURE

The two main design approaches utilized in the specific design of a threat environment are; (1) a generic algorthm in which parameters are incorporated to define a specific threat, and (2) a threat model that simply defines a specific threat. The generic algorithm tends to be a more flexible, simpler, less costly approach, but requires more computer assets and provides less fidelity than the stand-alone model approach. It is important to clearly define the threat environment fidelity requirements and the features required in the models, so the contractor will select the correct model architecture for the effort.

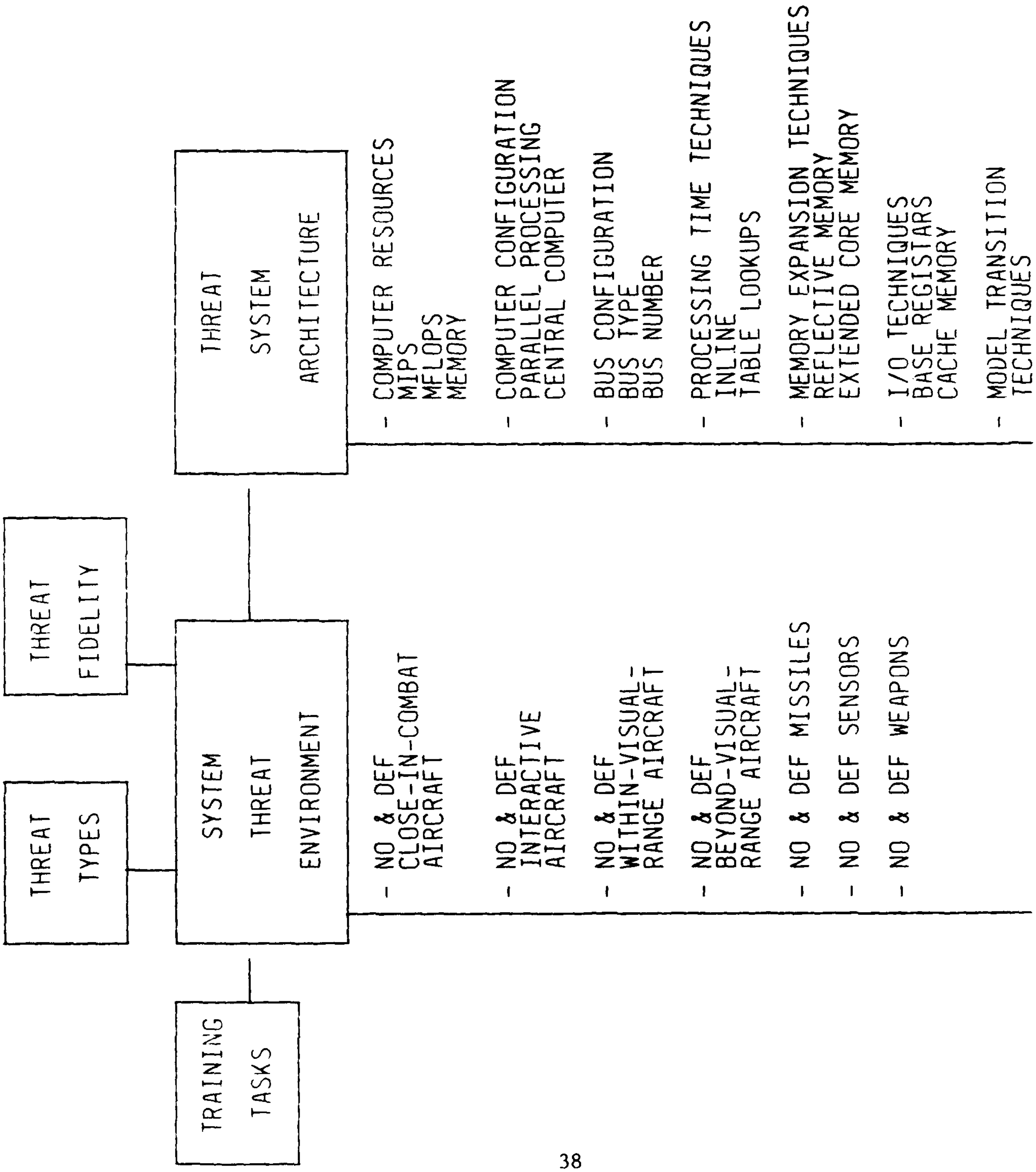


FIGURE 6. THREAT ENVIRONMENT

SYSTEMS REQUIREMENTS REVIEW	SYSTEM DESIGN REVIEW	SOFTWARE SPEC REVIEW	PRELIMINARY DESIGN REVIEW	CRITICAL DESIGN REVIEW	TEST READINESS REVIEW	SYSTEM INTEGRATION AND TESTING
			PROVIDE PRELIMINARY ESTIMATE OF	PROVIDE UPDATED ESTIMATE OF		

1. THREAT ENVIRONMENT COMPUTER ARCHITECTURE ANALYSIS
2. THREAT MODEL SOFTWARE ARCHITECTURE
3. THREAT MODEL MEMORY REQUIREMENTS
4. THREAT MODEL COMPUTIONAL TIME REQUIREMENTS
5. PROVIDE MATH MODEL REPORT
6. PROVIDE THREAT MODELS TO GOVERNMENT 90 DAYS PRIOR TO FACILITY INSTALLATION FOR OFF-LINE COMPUTER VALIDATION

FIGURE 7. MIL STD 2167 REVIEW SCHEDULE WITH DESIGN FACTORS REQUESTED DOD STD 2167A.

REFERENCES

1. R.F. Homing Guided Missile Design Specification, FAAC Perceptronics, Inc., Report Number FPM 1938U/4005, 25 August 1988.

2. Weapon Simulation Development White Paper, FAAC Perceptronics, Inc., Report Number FR3194U/7825, December 1987.

3. F-14D Simulator, Threat Aircraft Fidelity Requirements Memorandum, Veda Corporation Memo, Number 33978-89U/P3081-010, 10 August 1989.

4. Weapons and Electronic Warfare Fidelity Requirements for the F-14D Trainer Specification, FAAC Perceptronics, Inc., Report Number FPR 3082U/4005 7 April 1989.

5. Alfred Gramp, Suggested Sources of Data For Simulation Development Memorandum, Naval Air Develpment Center, 30 July 1990.

6. G. Terry Thomas and George DeLisi, AIM-9L Sidewinder Missile TACTS Range Model Validation Report, Naval Air Development Center, 30 September 1990.

APPENDIX A

F-14D TRAINER

REQUEST FOR PROPOSAL

THREAT ENVIRONMENT

3.1.5.6.3 Tactical Environment. - The tactical environment of the trainer shall encompass the trainer's simulated geographic domain (as defined in 3.1.5.6). The tactical environment shall simulate the effects of the earth's curvature including extreme latitudes. Variable day/night meterological conditions shall be included with a corresponding effect on the tactical environment. The tactical environment shall also simulate the following:

(a) Operational air threats
(b) Operational surface threats
(c) Operational ground threats
(d) Active emitters
(e) IFF responses
(f) Communication/Radio navigation stations
(g) Active countermeasures
(h) Passive countermeasures
(i) Air-to-air missiles
(j) Air-to-surface missiles
(k) Air-to-ground missiles
(l) Surface-to-air missiles
(m) Ground-to-air missiles
(n) Surface-to-surface missiles
(o) Ground-to-surface missiles
(p) Data Link (Link 4A, JTIDS)
(q) Radar Beacon Forward Air Control-Target Data Communicator (A-6F Only)

3.1.5.6.3.1 Tactical Gaming Area. - Tactical gaming areas shall be selectable by the instructor/operator. The tactical gaming area shall encompass air space from ground/sea level to an altitude of 150,000 feet with a ground range of 2000 nm by 2000 nm. Calculations for the tactical gaming area shall be in accordance with 3.1.5.1.10.2 atmospheric/geographic simulation through 3.1.5.1.10.8 magnetic variation. Control of the tactical environment shall be accomplished at the IOS console.

3.1.5.6.3.2 Threats. - Threats shall consist of the following:

(a) Air Platforms (Aircraft)
(b) Surface Platforms (Ships)
(c) Ground Platforms
(d) Ground Sites
(e) Air-to-Air Missiles
(f) Air-to-Surface Missiles
(g) Air-to-Ground Missiles
(h) Surface-to-Air Missiles
(i) Ground-to-Air Missiles
(j) Surface-to-Surface Missiles
(k) Ground-to-Surface Missiles
(l) Decoys

A site is the simulated location of any system represented by a jammer, radar, missile system, missile launch complex, or fire control system which remains fixed during the simulated scenario.

A platform is the simulation of ground, surface or air vehicles associated with any system represented by a jammer, radar, missile system or fire control system which have the capability to move during the simulated scenario.

It shall be possible to detect these threats by the appropriate ownship sensors as defined in the sensor paragraphs specified herein. Sensor detection of threats shall replicate that achieved with the operational equipment aboard the design basis aircraft. Probability of detection shall be based on threat range, aspect, electromagnetic emission, day/night meterological conditions and position from ownship.

Targets are defined as any threat that can be engaged and destroyed by ownship. Targets are a subset of threats and include all of the above except air-to-air missiles and surface-to-air missiles. Emitters shall consist of jammers, radar systems and electromagnetic guidance systems. The simulation shall correlate active emitters with threats.

It shall be possible to place the following number of targets/parameters (as a minimum) within any scenario at any location either during the plan modes or during the execution of a scenario:

Aircraft	96
Missiles	32
Ground (moving)	12
Ground (fixed)	48
SAM/AAA Sites	48
Surface (ships)	48
Weather Patterns	12

The instantaneous simultaneous target/parameter requirements are specified in the Threat and individual subsystem paragraphs.

The visual system shall dynamically compute which targets to display to the aircrew as a result of range, position and its threat priority to ownship.

3.1.5.6.3.2.1 Threat Database. - The parameters necessary to model threats and emitters shall be maintained in the trainer's online database. The simulation program shall provide the instructor/operator with the capability to assign specific emitters to individual threats or a group of threats during the plan mode, while the training mission is underway, or shall allow the computation subsystem to allocate emitters to threats via a default configuration assignment. The following data base shall be provided:

(a) Airborne Threats:

(1) 32 types of Airborne Platforms
(2) 18 types of Antiship Missiles

(aa) Air-to-Surface Missiles
(bb) Surface-to-Surface Missiles

(3) 24 types of Air-to-Air Missiles
(4) 18 types of Surface-to-Air Missiles

(b) Surface Threats - 12 types of surface platforms (F14)
- 37 types of surface platforms (A6)

(c) Ground Threats - 128 types of ground sites/platforms

(d) Emitters:
(1) 24 types of jamming techniques
(2) 128 types of radar, missile systems and fire control systems.

The threats to be provided for the data base will be chosen by the procuring activity from the threat listings in Appendix VI.

3.1.5.6.3.2.2 Threat Tactical Capabilities. - Threats shall be capable of joint or independent operation. These threats shall have tactical capabilities that fall into one of the following categories:

(a) Interactive Threats - An interactive threat shall make a tactical analysis of the scenario based on visual limits, passive and active sensors and data link/command control information. The threat shall employ its performance characteristics, sensors, weapons, and defensive countermeasures to survive and accomplish its mission. There shall be three levels of threat capabilities which shall vary the speed and effectiveness of the threat's reaction to the scenario and the simulation shall incorporate provisions for the effects of the enemy's tactical doctrine upon the threat's behavior. The capability shall be provided for dynamic and simultaneous simulation of twelve (12) interactive threats selectable by the instructor from the threat data base.

(b) Preprogrammed Threats - Threats shall perform a programmed (programmed during plan mode) course and mission without reacting to changes in the tactical environment.

(c) Instructor Controlled Threats - The capability shall be provided for the instructor/operator to control threats from the IOS. This capability shall include independent or joint maneuvers. The IOS shall also provide the capability for the instructor/operator to select and designate the lead threat in each attacking cell.

3.1.5.6.3.2.2.1 Airborne Threats. - Airborne threat simulation shall consist of both friendly and hostile air platforms, hostile and friendly air to air, air to ground/surface, ground/surface to air, ground/surface to ground/surface missiles and decoys. The capability shall be provided for dynamic simulation for one-hundred-sixty (160) simultaneous airborne threats at any time during any scenario. The 160 airborne threats shall be comprised of ninety-six (96) aircraft, thirty-two (32) air-to-surface missiles (ASMs), (24) air-to-air missiles (AAM) and eight (8) surface-to-air missiles (SAM). Airborne threats shall be capable of being grouped into twelve (12) attacking cells each of which is comprised of four (4) different threat types. Each attacking cell shall consist of one lead threat with as many as twenty-three (23) other threats in a slave relationship with the lead threat. This lead/slave relationship shall entail the slave threat performing identical maneuvers in consonance with the lead threat. The capability shall be provided for the instructor to vary the types of threats in a cell from one to four and the number of slave threats in a cell from one to twenty-three. Velocities, altitudes, climb rates and turn rates of each air threat shall accurately simulate the dynamics and performance of the air threats in the threat data base. Air threats shall have varying levels of tactical capabilities as required by 3.1.5.6.3.2.2

Each Air Platform shall have its appropriate sensors, weapons/EW systems and countermeasures. All air threats shall present accurate visual and electromagnetic profiles. The IOS shall contain all necessary controls for modifying the air threat tactical capability during the plan submode and varying it during the run mode.

3.1.5.6.3.2.2.1.1 Missile Flyout Profiles. - Missiles employed by ownship and threat platforms shall react realistically to changes in the tactical environment. Dynamic missile flyout profiles for ownship and threat missiles shall be included for EW and non-EW environments. Simulation of missile smoke trails shall be included. Radar cross sections (RCS) shall be included for air-to-surface cruise missiles and surface-to-surface cruise missiles. Probability of kill (PK) as well as missile performance characteristics shall be included in the simulation. These requirements apply to within visual range and beyond visual range scenarios.

3.1.5.6.3.2.2.2 Surface Threats. - Surface threats shall be comprised of friendly and hostile surface platforms. Each surface threat shall have appropriate sensors, weapons/EW systems and countermeasures.

All surface threats shall present accurate visual and electromagnetic profiles. Surface threat headings/courses and speeds shall simulate the performance and characteristics of those surface threats in the threat data base. The capability shall be provided for the dynamic simulation of twelve (12) surface threats simultaneously at any time during any scenario. Ship threats shall have varying levels of tactical capabilities as required by 3.1.5.6.3.2.2.

3.1.5.6.3.2.2.3 Ground Threats. - Ground threats shall be comprised of friendly and hostile ground platforms and sites. Each ground threat shall have its appropriate sensors and weapons/EW systems. All ground threats shall present an accurate visual and electromagnetic profile. Ground threats shall simulate the characteristics of those ground threats

in the threat data base. The capability shall be provided for the dynamic simulation of twelve (12) active ground threats simultaneously at any time during any scenario. Ground threats shall have varying levels of tactical capabilities as required by 3.1.5.6.3.2.2.

3.1.5.6.3.2.3 Electronic Warfare and Weapon Simulations. - Weapon and electronic warfare simulations employed in these trainers shall utilize existing Government Furnished weapon and EW simulation software modules from the Tactical Aircrew Combat Training System (TACTS) library to support simulator operation. This Government furnished software shall be incorporated into the trainers in accordance with the Naval Air Development Center's "NAS Fallon Tactical Aircrew Combat Training System Weapon and Electronic Warfare Simulations Interface Specification" (TF-2013-82-15, Rev. K, dated 26 November 1985). In addition, the Contractor shall develop simulations for weapons and EW simulations not currently existing in the Government's Tactical Air Training System library and for the existing simulations that do not meet the requirements of this specification. All Contractor developed weapon and EW simulations shall be in accordance with NAS Fallon's TACTS Interface Specification (TF-2013-82-15, Rev. K dated 26 November 1985). Modification of Government Furnished weapon and EW simulation software shall require approval of the procuring activity.

3.1.5.6.3.2.3.1 Electronic Warfare Simulation. - The simulation shall include the appropriate capabilities and vulnerabilities of the threats and ownship to electronic warfare.

The dynamic simulation shall include the following Electronic Warfare Systems:

(a) Jammers (e.g. airborne self protection, standoff/escort)
(b) Dispensable decoy jammers
(c) Dispensable chaff
(d) Dispensable flares

The degree of degraded performance of sensors, weapon systems, etc., shall be determined by geometry, effective radiated power, mode of operation, antenna pattern and field of view.

Threats shall use both passive and active electronic warfare techniques. The active techniques shall consist of emitters with realistic adjustable power levels.

3.1.5.6.3.2.3.1.1 Jamming Techniques. - Jammers are divided into two basis categories: (1) Standoff Jammers (SOJ)/Escort Jammers, and (2) Self Protection Jammers (SPJ). Cooperative jamming shall be limited to one pair of hostile aircraft at any time during the scenario.

3.1.5.6.3.2.3.1.2 Dispensable Countermeasures. Chaff, Flares and Decoys. - Threats and ownship shall be capable of deploying chaff, flares and decoys as specified herein.

3.1.5.6.3.2.3.1.2.1 Chaff Simulation Requirements. - Chaff bundles nd corridors shall be simulated. All chaff dispensed shall have djustable drop rates and frequency bandwidth responses. Threats shall be apable of dropping bundle chaff or using forward firing bundle chaff chaff rockets). Chaff bundles shall have a Radar Cross Section (RCS) of 0 to 10,000 square meters and a bloom time of from 0.1 to 10 seconds bloom time is the time from launch until chaff reaches maximum RCS). all rate shall be variable from 50 to 250 feet per minute. Chaff orridors shall be from 1 to 100 nm in length and shall be formed by an ircraft dispensing a stream of chaff that shall form a continuous orridor. Decay time shall be up to two hours and be specified by instructor/operator input with default to a standard value.

3.1.5.6.3.2.3.1.2.2 Expendable Jammers. - The effects of an expendable jammer employing one of the jamming types in the threat data base shall be simulated. Jammer ERP shall be limited to 50 dBm.

3.1.5.6.3.2.3.1.2.3 Offboard Decoys. - The effects of passive offboard decoys (up to 10) shall be simulated. The RCS of the decoys shall be selectable by the instructor/operator from 10 square meters to 1000 square meters with a default value equal to launching platform RCS.

3.1.5.6.3.2.3.1.3 Effects of EW on Probability of Kill (PK). - Friendly and hostile missile flyout simulation in a non-EW environment shall be as specified in 3.1.5.6.3.2.2.1.1. In an EW environment the missile flyout profile and its PK shall be altered as a function of the effectiveness of the EW with corresponding visual effects.

3.1.5.6.3.3 Instructor/Operator Control. - The instructor/operator shall have the capability, at the IOS, of modifying any threat's capability during the plan mode and run state. Each threat platform shall have its standard suite of sensors, weapons and EW systems modeled in the simulation with the capability for the instructor/operator to modify, select or change each threat's suite of sensors, weapons and EW systems. Each threat shall be capable of independent maneuvering, via computer control or via controls at the IOS, or as slaved threats to one or more threat formations. The threat simulations shall accurately model the performance and characteristics of those threats in the threat data base. Threat dynamics shall be automatic and shall require instructor/operator intervention only when a change from the preprogrammed parameter is desired.

3.1.5.6.3.3.1 Scenario Preparation and Control for EW, SAMS, AAA and AI. - The capability shall be provided at the IOS to assign air, surface and ground platforms/sites an EW capability consistent with the enemy's capabilities, tactics and doctrine. Similarly, the capability which will allow an instructor/operator (during scenario preparation) to locate SAMS and AAA sites around any desired line of defense shall be provided.

Anti-aircraft artillery (AAA) is defined as guns and unguided rocket projections dedicated to surface-to-air use. An airborne interceptor (AI) is an aircraft used to find and close with another aircraft.

3.1.5.6.3.3.1.1 Scenario Preparation. - For scenario preparation the capability shall be provided to allow an instructor/operator the following options:

(a) Assign ECM to air, surface, or ground threats, or default to a standard ECM suite.

(b) Assign initial activation times for ECM, chaff, off board decoys, flares, and cooperative jamming, (1) unconditionally, or default to a standard range value between jamming and victim platform, (2) conditionally, based on range between specified platforms, (3) conditionally, based on the occurrence of an overt event such as missile launch, ownship radar mode change, chaff, off board decoys, flares or cooperative jamming or (4) conditionally, based on a combination of range between two specified platforms and an overt evert(s).

(c) Assign one of three levels of intelligence to jamming platform as follows:
(1) Dumb - Jammer stays in same mode after activation.

(2) Human operator - Jammer changes modes in same manner as competent operator.
(3) Computer controlled system - Jammer changes mode automatically and rapidly as would a smart computer managed system employing a look through capability.

The instructor shall be able to adjust jamming power levels from 0 to 90 dbm.

For (2) and (3) above, the actual response shall be controlled by the simulation system software by comparing types of on-board jammers with ownship operating modes, and relative effectiveness.

(d) Assign hostile RCS profile or default to a standard value. Refer to 3.1.5.6.3.2.3.1.2.2.

(e) Assign RCS to passive offboard decoys.

(f) Assign bloom time, fall rate, start and end point (corridors only) and decay time to chaff corridors or bundles.

(g) Place SAMS and AAA sites at any desired location within gaming area with type and numbers as contained in the threat data base.

(h) Activate emitters associated with particular SAMS, AAA and AI, (1) unconditionally at any time, (2) conditionally based on threat envelope, geometry and tactics, or (3) default to a standard range value.

(i) The capability to allow missile systems to be assigned to airborne targets shall be provided.

3.1.5.6.3.3.2 Scenario Control. - For scenario control, the capability shall be provided to allow an instructor/operator to preempt any condition or value which was assigned during scenario and assign a new value or condition within system limitations.

3.1.5.6.3.4 Air Launched Missiles. - Air platforms shall have the capability to launch missiles against the ownship and sea targets as defined below:

3.1.5.6.3.4.1 Threat Air-to-Air Missiles (AAM). - Any of the air platforms shall be capable of launching their appropriate AAMs against ownship and other air platforms. The capability shall be included for twenty-four (24) AAMs to be in flight at any time. Each AAM shall have appropriate flight parameters and performance characteristics for those threats in the threat data base.

3.1.5.6.3.4.2 Ownship Air-to-Air Missiles. - The capability shall be provided to launch the types of missiles defined in 3.1.5.1.5.

3.1.5.6.3.4.3 Threat Air-to-Surface Missiles (ASM). - Air platforms shall be capable of launching their appropriate ASMs against all surface platforms and the ownship aircraft carrier. Each air platform shall be capable of launching up to three (3) ASMs at any given time. The capability shall be included for thirty-two ASMs to be in flight at any time. Each ASM shall have appropriate flight parameters and performance characteristics for those threats in the threat data base.

3.1.5.6.3.4.4 Ownship Air-to-Surface Missiles. - The A-6F (ownship) shall be capable of launching the types of missiles defined in 3.1.5.1.5 of specification A128WSTSS200.

3.1.5.6.3.5 Gun Simulation. - Any of the air platforms shall be capable of firing their appropriate guns at the ownship. The F-14D (ownship) shall be capable of firing the M61A1 20mm cannon at any threat.

3.1.5.6.3.6 Surface-to-Air Sites. - Surface-to-air missile (SAMs) sites and anti-aircraft artillery (AAA) sites shall be included in the simulation. These SAM and AAA sites shall constitute an origin for missile launches against own aircraft. The capability shall be provided for 12 sites to be active at any time during the mission/scenario. These active sites shall consist of SAM sites and AAA sites in any combination. Each site shall be specified as ground-based or surface-based. The electromagnetic emission characteristics associated with SAM and AAA sites along with their associated missile flight performance characteristics shall be simulated.

3.1.5.6.3.2 Threats. The requirements of Specification 5CSACT100 Paragraph 3.1.5.6.3.2 shall apply.

3.1.5.6.3.2.1 Threat Data Base. The requirements of ecification A55CSACT100 Paragraph 3.1.5.6.3.2.1 shall apply.

3.1.5.6.3.2.2 Threat Tactical Capabilities. The requirements Specification A55CSACT100 Paragraph 3.1.5.6.3.2.2 shall apply.

3.1.5.6.3.2.2.1 Airborne Threats. The requirements of ecification A55CSACT100 Paragraph 3.1.5.6.3.2.2.1 shall apply.
ommand Options: d8kmoswTalJ Keys: X=exit ?=Help

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3.1.6.1.1.4.1.6.1.7 Other Models. Other models shall include models sed for generating images used in tactical training scenarios. Moving and xed models shall include the following:

(a) Aircraft - Aircraft shall be modeled to include all details and markings to provide positive recognition as to type and aspect from maximum ranges compatible with size and image resolution. Size exaggeration shall be used if needed for detection to the maximum ranges specified. If wire model images are used for multiple simultaneous aircraft image simulation, a hidden line removal technique shall be employed to provide aircraft aspect cues. At least two aircraft shall be computed and displayed from the fully modeled data base when more than one aircraft is in view. Aircraft types to be modeled are referenced in Specification A55CSACT100 Paragraph 3.1.5.6.3.2.1 (Threat Data Base).

(b) Missiles - Surface-to-air missiles shall be modeled to include plume and missile body adequate to provide for detection and aspect determination. Size exaggeration may be used if required for detection to the maximum ranges specified. Missile types to be

simulated are referenced in Specification A55CSACT100 Parag 3.1.5.6.3.2.1 (Threat Data Base).

Ground-based missile launch sites, representative of the surface-to-air missile types shall be modeled for inclusion in the high-speed low-level flight corridor terrain areas.

(c) Own Weapons - Simulation of own weapons release shall include tracer path for firing of Gatling gun. Simulation shall include start and stop of firing burst under computer control. The trajectory of shells shall be represented in the display. Firing of air-to-air or air-to-ground weapons shall be provided via simulation of missile plume and missile trajectory.

(d) Anti-Aircraft Artillery (AAA) - AAA shall be simulated to include muzzle flash.

(e) Ships and boats - Surface ships and boats shall be modeled to include all major features required to provide positive recognition identification and aspect from the maximum ranges compatible with size of the ship type. Twelve types of ships shall be modeled. Ships and boats to be simulated are referenced in Specification A55CSACT100 Paragraph 3.1.5.6.3.2.1 (Threat Data Base).

(f) Ground Targets - Ground targets shall be placed within the low-level high-speed flight corridors. Ground targets shall include the SAM

3.1.6.1.1.4.1.6.2.7 Other Models. Other moving models shall be in accordance with Paragraph 3.1.6.1.1.4.1.6.1.7.

Hostile aircraft shall be detectable at ranges according to the aircraft size and accuity of the human eye. Size and/or object brightness shall be exaggerated if necessary to provide detection capability.

Firing of own weapons and hostile weapon firing shall be represented. Air-to-air missiles shall be represented by rocket plume. Own ship Gatling gun fire shall be represented by tracer images. Visually displayed airborne targets and missiles shall not exceed more than 5 at any one time (gunfire tracer is not counted as a target).

Airborne target presentations in the visual system shall be coordinated with the range and relative position as indicated by the sensors being used at that time (e.g. Radar, TV and IR).

3.1.6.1.1.4.1.7.1.2 Surface-to-Air Missile Evasion. Scenes simulating surface-to-air missile attack against the F-14D shall be displayed to provide practice in surface-to-air missile evasion tactics. The missiles shall be launched from a typical SAM site placed within a generic area from the IOS. Up to 5 active SAMs shall be visually displayed at any one time. If other airborne targets are presented the sum of such targets and missiles shall not exceed 5. Launch and flight of SAMs shall be coordinated between visual and sensors displays.

3.1.6.1.1.4.1.7.1.3 Surface Attack. Scenes simulating the F-14D launching missiles against ships or land-based targets shall be simulated. The simulation shall include missile rocket exhaust as the missile travels toward the target. Missile hits shall be displayed by a bright flash at the target. Launch of SAMs from the ship under attack shall be simulated. Up to 5 SAMs shall be in flight at any one time.

3.1.6.1.1.4.1.8.6.1 Moving Model Control. Control of moving models hall be via the trainer computation system in response to instructor control nputs or from automated moving model control as part of the training cenario. Up to 5 simultaneous moving models (air or sea surface) in any ombination having independent axis systems shall be generated and displayed. ommands shall include:

(a)	Airborne Targets		up to 5 of 24 types
	Moving Model select		0-360° all axes
	Target Aircraft attitude		x,y,z
	Target Aircraft	position	0-2.8 Mach
	Target Aircraft	velocity	own ship or any hostile
	Gun Fire	fire	own ship or hostile
	Missile Launch	fire	any of 18 types
	Surface-to-air missile	fire	any of 2 types
	Anti Aircraft artillery	fire	

(b)	Surface Targets		Up to 5 of 12 types
	Ship Select		0-360°
	Heading		0-30 knots
	Speed		
	Ship position	Lat/Long	

4.2.2.7.3.15 Weapon System Tests. - Tests shall be conducted to demonstrate operation of the arming and release system and weapon characteristics such as velocity, range, and accuracy. Guns and all specified missiles shall be tested using previously validated NADC real-time weapon simulations as standards, and shall conform to these standards within the following tolerances.

(a) Missiles
  (1) Velocity at intercept: ±5 percent
  (2) Time of flight: greater of ±5 percent or ±0.05 second

(b) Gun
  (1) Velocity of first bullet nearest to target: ±5 percent
  (2) Time of flight (first bullet of a burst): greater of ±5 percent or ±0.1 second.

APPENDIX B

F-14D TRAINER

ҶUEST FOR PROPOSAL

LIST OF THREATS

Th eat/Emitter Group Allocations (FOR OFFICIAL USE ONLY) 4/6/89

GROUP 1

* B	BACKNET
* B	TALL KING
* B	ODD PAIR
* B	SIDE NET
* B	BIG BIRD
* B	FLAT FACE
* B	THIN SKIN
* B	SPOON REST
* B	SQUAT EYE

GROUP 2

* B	MIG-21
* B	JAY BIRD
* B	MERSHIP
* B	EW SITE TYPE 1
* B	EW SITE TYPE 2
* B	EW SITE TYPE 3
* B	EW SITE TYPE 4
* B	EW SITE TYPE 5
* B	EW SITE TYPE 6
* B	EW SITE TYPE 7
* B	EW SITE TYPE 8
* B	EW SITE TYPE 9
* B	EW SITE TYPE 10
* B	EW SITE TYPE 11
* B	EW SITE TYPE 12
* B	EW SITE TYPE 13
* B	EW SITE TYPE 14
* B	LONG TRACK
* B	GCI SITE TYPE 1
* B	GCI SITE TYPE 2
* B	GCI SITE TYPE 3
* B	BARLOCK

GROUP 3

B	MIG-23
B	HIGHLARK II
B	MIG-25
B	HIGH LARK IV
B	MIG-29
B	END RUN
B	MIG-31
B	FLASH DANCE
B	SU-27
B	SLOT BACK
B	BIG BULGE
B	DOWN BEAT
B	SQUASH DOME
B	SU-24
B	SA2E TYPE 1
B	SA2E TYPE 2
B	SA2E TYPE 3
B	SA2E TYPE 4
B	FAN SONG E/W
B	FLAP WHEEL
B	FIRE CAN
B	SA2F TYPE 1
B	SA2F TYPE 2
B	SA2F TYPE 3
B	FAN SONG F
B	SA3 TYPE 1
B	SA3 TYPE 2
B	LOW BLOW
B	STRAIT FLUSH
B	SA8 TYPE 1
B	SA8 TYPE 2
B	SA8 TYPE 3
B	SA8 TYPE 4
B	LAND ROLL
B	GUN DISH

GROUP 4

C	MIG-17
C	TU-95
C	TU-26
D	SU-20
C	HIGH FIX
D	TU-16
C	PUFF BALL
D	IL-38
D	IL-76
C	TU-22M
E	SUPER ETENDARD
	?
E	KFIR
	?
E	MIRAGE F-1
C	CYRANO IV
E	MIRAGE 2000
	?
E	JAGUAR
E	TORNADO
C	DECCA 72
C	HOKUM
C	SA5 TYPE 1
C	SA5 TYPE 2
B	SQUARE PAIR
C	SA6 TYPE 1
C	SA6 TYPE 2
C	SA6 TYPE 3
B	SA7
C	SA14
B	SA9
B	SA13
E	DOG EAR
B	SA10 TYPE 1
B	SA10 TYPE 2
B	FLAP LID
B	CLAM SHELL
C	SA11 TYPE 1
C	SA11 TYPE 2
C	SA11 TYPE 3
C	SA11 TYPE 4
B	FIRE DOME
B	TUBE ARM
C	SNOW DRIFT

STATUS CODES:

- * - COMPLETED AND SUBMITTED
- A - ALL DATA AVAILABLE TO INCORPORATE
- B - MAJORITY OF DATA AVAILABLE - MINOR HOLES
- C - ABOUT 50% DATA AVAILABLE
- D - ABOUT 25% DATA AVAILABLE
- E - LESS THAN 10% DATA AVAILABLE

Threat/Emitter Group Allocations (continued) (FOR OFFICIAL USE ONLY) 4/6/89

GROUP 5

D	KIROV	
C		TOP DOME
C		TOP PAIR
C		SHOT ROCK/DOME
D	SLAVA	
C		KITE SCREECH B
D	SOVREMENYY	
C		FRONT DOME
C		BAND STAND
D	UDALOY	
C		EYE BOWL
C		TOP PLATE
C		STRUT PAIR 1
D	NANUCHKA	
C		MUFF COBB
C		PEEL PAIR
C		MIUS
D	KRIVAK	
C		HEAD NET A/C
C		DON II
C		LOW TROUGH
C	KRESTA	
C		PEEL GROUP
C		SCOOP PAIR
C		BIG NET
C	MOD KASHIN	
C	KARA	
C	OSA I	
C		DRUM TILT
C		SQUARE TIE
C	GRISHA	
C		STRUT CURVE
C	TARANTUL	
D	ECHO II	
C		SNOOP TRAY
C		SNOOP SLAB
C	BORIS CHILIKIN	
C	KIEV (BAKU)	
C		CROSS SWORD
C		POP GROUP
C		HEAD LIGHT C
C		FRONT DOOR B
C		KITE SCREECH
C		BASS TILT
D		RUM TUB
C	KIEV (OTHER)	
C		FRONT DR/PIECE
C		OWL SCREECH
C		TOP SAIL
C		TOP STEER
C		STRUT PAIR 2
C		PALM FROND A/B
C		DON KAY

GROUP 6

D	F-14D	
C		APG-71
E	F-4S	
D		AWG-10
E	F-5E	
C		APG-153
E	F-15C	
C		APG-63
E	F-16N	
C		APG-66
E	F/A-18	
C		APG-65
E	A-6E	
C		APQ-156
E	AV-8B	
E	E-2C	
E		APS-125
E	EA-6B	
E		APS-130
D	MIKE	
C		SNOOP HEAD
D	FOXTROT	
C		SNOOP PLATE
D	BRESHNEV	
C		PLATE STEER
E		CAKE STAND
C	LUDA	
C		WASPHD/SUNVISR
C		RICE LAMP
C		P/BEAN STICKS
C		FIN CURVE
C		DECCA 707/909
E	SAAM	
C		PLESSY AWS-1
C		VITEX FC SYST
C		CONTRAV SEA HN
E	LA COMBATTANTE	
C		HSA WM 28
C		OTO MELARA
C		M-20
C		DECCA 1226
C		DECCA 1229
E	LEANDER	
C		M45, 2M44
B	SA12	
B		GRILL PAN
C		BILL BOARD
B		TIN SHIELD
C	SA-X-15	
D		SCRUM HALF
C	SA16	
D		IR

GROUP 7

D	NAJIN	
C		POT DRUM/HEAD
C		SLIM NET
E	WADI M'RAGH	
C		RAN 11/12
C		RTN-10X/ORION
E	NIMITZ	
C		MK-95/115
C		PHALANX
C		SPS-48
C		SPS-49
C		SPS-10B-G
C		LN-66
C		SPS-59
C		SPN-10
E	IOWA	
C		MK 25 MOD 3
C		MK 27 MOD 7
C		SPG-34, MK 34
C		SPS-64,67/LN-66
C	HAWK	
C		HPI
C		CWAR
C		PAR
C	RAPIER TYPE 1	
C	RAPIER TYPE 2	
C		BLIND FIRE
C		ACQ
C	CROTALE	
C		MIRADOR II
C		TMD-5000
D	RBS-70	
D		LASER GUIDED
D		GIRAFFE
C	ROLAND	
C		MPOR-16
C	AAA 57MM TYPE 1	
C	AAA 57MM TYPE 2	
C	AAA 57MM TYPE 3	
C	AAA 57MM TYPE 4	
C	AAA 57MM TYPE 5	
C	AAA 57MM TYPE 6	
B		WHIFF
C	AAA 35MM	
C		SUPER FLEDERMS
B	ZSU-23-4	
C	ZSU-X	
E	GEPARD 35MM	
C		SIEMUS
C		MPOR-12

GROUP 8

E	TICONDEROGA	
C		SPY-1A/MK-90
C		SPG-9, SPQ-9A
C		SPS-55
E	VIRGINIA	
C		SPG-51B-D
C		SPG-55B
C		SPG-60
C		SPS-40
E	SPRUANCE	
C		IPOTAS MK23
E	CHARLES ADAMS	
C		SPG-53A-F
C		SPS-39
E	WICHITA	
E	ARLEIGH BURKE	
E	OLIVER HAZARD	
C		MK-92 CAS
C		MK-92 STIR
E	TARAWA	
C		SPS-52B
D	OSA II	
		?
		?
D	CHARLEE II	
D	OSCAR	
C	GEN PATROL BOAT	

F-14D WEAPON LIBRARY

		TACTS MODEL AVAILABLE	OWNSHIP WEAPON
R TO AIR MISSILES			
	AIM-7F/M	YES	YES
	AIM-9H	YES	
	AIM-9L	YES	YES
	AIM-9M	YES	YES
	AIM-54C	YES	YES
	AIM-120		YES
	AA-2D	YES	
	AA-6D ACRID		
	AA-7 (AA-7A/C/D)	YES	
	AA-8 APHID	YES	
	AA-9 AMOS	YES	
	AA-10A	YES	
	AA-10C	YES	
	AA-10E		
	AA-11		
	M550 MAGIC I	YES	
	M550 MAGIC II		
	M530 SUPER D		
	AAAM		
	ASRAAM		
	AA-10B ALAMO	YES	
IR TO AIR GUNS			
	20 MM M61A1	YES	YES
AA GUNS			
	130 MM		
	114 MM		
	100 MM		
	76.2MM		
	57 MM	YES	
	50 MM		
	45 MM		
	40 MM		
	37 MM		
	35 MM		
	30 MM		
	25 MM		
	20 MM		
	CIWS PHALANX		
	16 INCH		
	5 INCH		
	ZSU-23-4	YES	
	ADGM-630		
	57 MM (MUFF COB)	YES	
	GEPARD 35 MM		

Encl (4)

F-14D WEAPON ALLOCATION

	TACTS MODEL AVAILABLE	OWNSHIP WEAPON
TO SURFACE MISSILES		
AGM-84A/C/D HARPOON	YES	
AGM-88 HARM	YES	
AGM-65E/F MAVERICK	YES	
AGM-45A/B SHRIKE	YES	
AGM-123A SKIPPER II		
AS-4 KITCHEN		
AS-5 KELT		
AS-6 KINGFISH		
AS-11		
EXOCET		
FACE TO SURFACE MISSILES		
TOMAHAWK		
SS-N-2A/B/C		
SS-N-3B		
SS-N-9		
SS-N-10		
SS-N-11		
SS-N-12		
SS-N-14		
SS-N-19		
SS-N-22		
SILKWORM		
CSS-N-2		
CSS-N-1		
SEAKILLER SSM		
HARPOON		

F-14D WEAPON ALLOCATION

	TACTS MODEL AVAILABLE	OWNSHIP WEAPON
RFACE TO AIR MISSILES		
SA-2E	YES	
SA-3	YES	
SA-6B	YES	
SA-8B	YES	
SA-10		
SA-11		
SA-12		
SA-16		
SA-5	YES	
SA-13		
SA-N-1		
SA-N-3		
SA-N-4		
SA-N-6		
SA-N-7		
SA-N-9		
IHAWK		
RAPIER	YES	
CROTALE		
SM-2ER		
SM-2MR		
PATRIOT		
SM-1MR		
SEA SPARROW		
SA-2F	YES	
SA-14		
SA-9	YES	
SA-X-15		
RBS-70		
ROLAND		
SEACAT		
SEA WOLF		

ADDITIONAL A-6F WEAPON LIBRARY

? TO SURFACE MISSILES	TACTS MODEL AVAILABLE	OWNSHIP WEAPON
AGM-84A/C/D HARPOON	YES	YES
AGM-88 HARM	YES	YES
AGM-65E/F MAVERICK	YES	YES
AGM-45A/B SHRIKE	YES	YES
AGM-123A SKIPPER II	YES	YES

ONANCE	TACTS MODEL AVAILABLE	OWNSHIP WEAPON
MK-81	.YES	YES
MK-82	YES	YES
MK-83 BSU-85B	YES	YES
MK-83	YES	YES
MK-84	YES	YES
MK-76	YES	YES
MK-106	YES	YES
B-57	YES	YES
BDU-20/C	YES	YES
B-61	YES	YES
BDU-36/C	YES	YES
CBU-59/B APAM	YES	YES
CPU-72B FAE I	YES	YES
CBU-78/B GATOR	YES	YES
CBU-88 SMOKEYE	YES	YES
GBU-10 C/B MK84 LGB	YES	YES
GBU-12 B MK82 LGB	YES	YES
GBU-16 B MK83 LGB	YES	YES
MK-25 MINE	YES	YES
MK-36 DST	YES	YES
MK-40 DST	YES	YES
MK-41 DST	YES	YES
MK-52 MINE	YES	YES
MK-55 MINE	YES	YES
MK-56 MINE	YES	YES
MK-60 MINE	YES	YES
MK-62 MINE	YES	YES
MK-63 MINE	YES	YES
MK-64 MINE	YES	YES
MK-65 QUICKSTRIKE MINE	YES	YES
MK-58 MARINE MARKER	YES	YES
MK-77 NAPALM	YES	YES
MK-20 ROCKEYE II	YES	YES
BDU-3301B	YES	YES
BDU-15/B	YES	YES
BDU-48/B	YES	YES
LAU-10 5" FFAR	YES	YES
LAU-61 2.75" FFAR	YES	YES
LAU-68 2.75" FFAR	YES	YES

A-6E SWIP WEAPON ALLOCATION

		TACTS MODEL AVAILABLE	OWNSHIP WEAPON
AIR TO SURFACE MISSILES			
	TACIT RAINBOW	NOT CURRENTLY	YES
	WALLEYE	NOT CURRENTLY	YES
	SLAM	NOT CURRENTLY	YES

APPENDIX C

F-14D TRAINER

REQUEST FOR PROPOSAL

OWNSHIP FIDELITY REQUIREMENTS

3.1.5.3 Tolerances. Unless otherwise specified, the tolerances herein shall apply throughout the entire range of operation of the design basis aircraft regardless of whether the range can be considered normal or abnormal. The tolerance shall apply to design basis aircraft data in the following order of preference:

(a) Directly measured aircraft flight test data.
(b) Corrected/normalized flight test data.
(c) Data extracted from test stand and wind tunnel tests.
(d) Analytical data.

Unless otherwise specified, the tolerance figures shall be construed to mean plus or minus values. The tolerances shall be applicable at any place the values may be read: i.e., at the computer, IOS, trainee station, etc. In cases where the accuracy of the operational aircraft instrument or indicator is less than the tolerance specified, the operational aircraft instrument accuracy shall be the tolerance for that instrument but not for the related parameter.

3.1.5.3.1 General. Performance characteristics of the design basis aircraft not covered by specific tolerances shall be assigned the following general tolerances within which the trainer shall operate. The general tolerance shall be applicable to the particular parameter involved, as provided in or derived from the aerodynamic data.

(a)	Total mass	1 percent.
(b)	Moments of inertia	1 percent or 0.1 percent of maximum value whichever is greater.
(c)	Attitude Accuracy	1 Degree.
(d)	Attitude Resolution	0.1 Degree.
(e)	Other	5 percent

3.1.5.3.2 Curve Slope. The curve slope of a trainer performance urve shall be within ± 10 percent (of same sign) of the curve slope of he corresponding trainer criteria curve at all points where the criteria urve is continuous unless otherwise specified herein.

3.1.5.3.3 Control System Tolerances. All force and moment characteristics shall be measured at the pilot's nominal point of application. Control stick and rudder pedal positions shall be defined as the position of those mechanical elements normally in contact with the pilot.

(a)	Surface deflections vs control deflection	0.5 degree
(b)	Control force vs control deflection	5 percent or ½ pound, whichever is greater.
(c)	Breakout plus friction force	½ pound
(d)	Friction band	½ pound
(e)	Free play	0.10 inch.
(f)	Time for operation of trim system, flap actuation, speed brake actuation, etc.	5 percent.
(g)	Damping ratio	0.05
(h)	Damped natural frequency	10 percent
(i)	Amplitude response	10 percent

3.1.5.3.4 Flying Qualities Tolerances. -

(a) Steady state trim points:

(1)	Angle of attack vs trim airspeed	0.5 unit angle of attack
(2)	Control deflection vs trim airspeed	10 percent or 1 degree whichever is greater
(3)	Trim surface deflection indication vs airspeed	10 percent or 1 degree whichever is greater
(4)	Approach speed vs gross (Optimum AOA)	1 knots IAS

(b) Longitudinal trim changes due to thrust changes and activation of appurtenances: during appurtenance activation (e.g., landing gear, wing flaps, speed brakes, wing sweep). All changes must exhibit the same sign as the criteria data.

(1)	Control position change	0.5 degree
(2)	Control force change	1 pound or 10 percent whichever is greater
(3)	Pitch angle change	1 degree
(4)	Angle of attack change	1 degree

(5)	Altitude change	Lesser of 10 feet or 10 percent of total change in altitude
(6)	Airspeed vs change	Lesser or 5 KIAS or 10 percent of total change in airspeed

(c) Static longitudinal stability:

(1)	Control deflection vs airspeed	0.5 degree
(2)	Surface deflection vs airspeed	0.5 degree or 10 percent whichever is greater
(3)	Control force vs airspeed	0.5 pound or 10 percent whichever is greater
(4)	Angle of attack vs airspeed	0.5 unit angle of attack

(d) Dynamic longitudinal stability:

(1)	Damping ratio	0.05
(2)	Undamped natural frequency	10 percent
(3)	Amplitude response	10 percent

(e) Maneuvering longitudinal stability:

(1)	Stick force per unit normal acceleration	10 percent or 1 lb
(2)	Control deflection vs normal acceleration	0.5 degree or 10 percent. whichever is greater
(3)	Angle of attack vs normal acceleration	0.5 degree or 10 percent. whichever is greater
(4)	Surface deflection vs acceleration	0.5 degree or 10 percent. whichever is greater

(f) Static lateral directional stability:

(1)	Lateral control deflection vs sideslip angle	0.5 degree or 10 percent. whichever is greater
(2)	Lateral control force vs sideslip angle	1 pound or 10 percent, whichever is greater
(3)	Lateral surface deflections vs sideslip angle	0.5 degree or 10 percent. whichever is greater

(4)	Roll angle vs sideslip angle	1.0 degree or 10 percent, whichever is greater
(5)	Directional control deflection vs sideslip angle	0.5 degree or 10 percent, whichever is greater
(6)	Directional control force vs sideslip angle	1 pound or 10 percent, whichever is greater

(g) Dynamic lateral directional stability:

(1)	Dutch roll period vs airspeed	10 percent
(2)	Dutch roll damping vs airspeed	0.05
(3)	Roll to sideslip ratio	10 percent
(4)	Sideslip angle vs time	10 percent or 1 degree of peak amplitude whichever is greater

(h) Spiral stability:

Roll angle vs time	20 percent and convergent or divergent as in aircraft

(i) Lateral control effectiveness:

(1)	Roll angle vs time	10 percent
(2)	Sideslip angle vs time	10 percent
(3)	Roll rate vs time	10 percent
(4)	Roll mode time constant	25 percent

(j) Engine Out Flying Qualities:

(1)	Minimum Control Airspeed	3 kts.
(2)	Dynamic Response to sudden engine failure (time response and magnitude of angular rates)	15 percent

(k) Stall characteristics (1g):

(1)	Buffet onset speed vs gross weight	2 knots
(2)	Stall speed vs gross weight	2 knots
(3)	Buffet onset angle of attack	0.5 unit
(4)	Stall angle of attack	0.5 unit

3.1.5.3.5 Power Plant Tolerances. -

(a)	Fuel flow	5 percent
(b)	RPM	5 percent
(c)	RPM vs power lever position	1 percent RPM at idle and greater than 90% RPM: 2 percent elsewhere
(d)	Engine windmilling speed	1 percent RPM
(e)	Engine RPM vs time	5 percent
(f)	Exhaust gas temperature	3 percent from idle to 75 percent RPM; 1.0 percent above 75 percent RPM and at idle
(g)	Oil pressure	5 percent
(h)	Thrust	3 percent, or 0.3 percent of maximum value whichever is greater
(i)	Light off time	10 percent
(j)	Fuel quantity	5 percent

3.1.5.3.6 Performance Characteristics. -

(a)	Rate of climb	5 percent or 50 feet per minute whichever is greater
(b)	Level acceleration/deceleration (time and fuel used)	5 percent
(c)	Maximum airspeed	3 knots or 1 percent whichever is greater
(d)	Turn performance (sustained and instantaneous)	5 percent or 0.1 g, whichever is greater

3.1.5.3.7 Ground Handling Characteristics. -

(a)	Heading angle vs time (parameterized against percent nose gear steering)	10 percent
(b)	Heading angle vs time (parameterized against percent differential wheel brake application)	10 percent
(c)	Ground speed vs time (parameterized against wheel brake application)	10 percent

3.1.5.3.8 Takeoff and Landing Characteristics.

(a)	Nosewheel liftoff speed vs gross weight and center of gravity (CG) position	2 knots
(b)	Takeoff Airspeed	2 knots
(c)	Takeoff time	1 sec
(d)	Stopping time	1 sec
(e)	Rudder and aileron effectiveness speeds	5 kts
(f)	Distance	10% of instantaneous aircraft value

3.1.5.3.9 System Operation Tolerances. - Unless otherwise specified in the detail specification, trainer system tolerances shall be as follows:

(a)	Hydraulic pressure	100 PSI
(b)	Hydraulic transients	1 sec
(c)	Electrical indications	5 percent
(d)	Power (electrical)	5 percent
(e)	Electrical device load	5 percent
(f)	Extension, retraction times	15 percent

(g)	General time delay (switch to light warm-up, etc.)	10 percent
(h)	Control force vs control deflection (Throttles, gear handle, etc.)	10 percent
(i)	Accumulator pressure	50 PSI
(j)	Actuator response time	1 second
(k)	Standby compass	3 degrees
(l)	Free air temperature	2 degrees
(m)	Accelerometer	0.1g
(n)	Cockpit altitude	100 feet
(o)	Gyro horizon indicator (all axes)	2 degrees
(p)	Turn indicator	1/10 needle width
(q)	Sideslip	1/4 ball width

3.1.5.3.10 Navigation Tolerances. - The navigation tolerances shall be as follows:

(a)	Relative bearing	2 degrees
(b)	Localizer beam location	1 foot
(c)	Localizer beam approach bearing	0.2 degree
(d)	Glidepath beam location	10 feet
(e)	Glidepath beam angle	6 minutes of arc
(f)	Gyro precession rate	25 percent, or 2 degrees : hour, whichever is less
(g)	Magnetic variation	0.1 degrees
(h)	Field elevation	10 feet
(i)	Signal attenuation vs distance	25 percent maximum range
(j)	Radio beam width	20 percent
(k)	Distance indicator	0.5 miles
(l)	Radio facility location	0.1 mile

3.1.5.4 Data. - Trainer design criteria shall be derived from F-14D/A-6F data and other data sources as may be necessary.

3.1.5.5 Scenarios. - The suite training mission shall be accomplished through training scenarios. Training scenarios shall be either automated or Instructor/Operator controlled as specified herein.

3.1.5.5.1 Automated Scenarios. - Automated (canned) scenarios shall provide totally preprogrammed training missions. All inputs usually required from an instructor/operator to conduct an individual training scenario (e.g. initial conditions, malfunctions, navigational facilities, etc.) shall be preprogrammed to occur when specified parame-ters are met. It shall be possible, via the IOS or the off-line work station, to construct individual preprogrammed (canned) training scenarios and store them on a disc (system or floppy) to be utilized at a future date. All features available to an instruc-tor/operator during free-flight shall be capable of prepro-gramming for incorporation into an automated scenario. Fifteen (15) complete scenarios shall be provided and shall be available for selection and activation from the system disc at any time.

3.1.5.5.2 Instructor/Operator Controlled Scenario. - The IOS control station shall provide the capability of tailoring an exercise to meet the needs of the individual trainee. The train-ing scenarios shall be under the positive control of an instructor/ operator who will be located at the IOS. The trainer shall provide the capabilities to permit